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Idaho Operations Office

Monitoring Report/Decision Summary for Operable Unit 3-13, Group 5, Snake River Plain Aquifer

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Prepared for the
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ABSTRACT

This Monitoring Report/Decision Summary serves as the remedial action report for Operable Unit 3-13, Group 5, Snake fiver Plain Aquifer at the Idaho Nuclear Technology and Engineering Center, located at the Idaho National Engineering and Environmental Laboratory near Idaho Falls, Idaho. This document provides an evaluation of the effectiveness of the selected remedial action for Group 5 *(Institutional Controls with Monitoring and Contingent Remediation).* Results are presented for a field investigation performed during 2002 to investigate the properties of the Snake fiver Plain Aquifer "HI interbed' (sediments between the "H" and "I" basalt flows). Groundwater monitoring results and trends for the aquifer through 2003 also are presented and summarized.

Based on the field and laboratory results of the HI interbed investigation, the groundwater contaminant transport model was revised. The model also included a revised estimate of the 1-129 source term at the former Idaho Nuclear Technology and Engineering Center injection well. The revised model output more closely resembles the observed Snake fiver Plain Aquifer radionuclide contaminant plumes.

There is no need to invoke the contingent remedy (groundwater pump and treat) for Group 5. Based on the results of field investigations and revised groundwater modeling, it is anticipated that the Group 5 remedy will be successful in achieving the remedial action objectives established for the aquifer by the year 2095.

EXECUTIVE SUMMARY

This Monitoring Report/Decision Summary serves as the remedial action report for Operable Unit 3-13, Group 5, Snake River Plain Aquifer (SRPA) at the Idaho Nuclear Technology and Engineering Center, (INTEC), located at the Idaho National Engineering and Environmental Laboratory near Idaho Falls, Idaho. This document is a required submission as specified in the *Remedial Design/Remedial Action Scope of Work for Waste Area Group 3, Operable Unit 3-13* (DOE-ID 2000) and is intended to assess the effectiveness of the selected remedial action for the SRPA groundwater contaminant plume associated with past operations at INTEC.

The remedy selected in the *Final Record of Decision Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13* (DOE-ID 1999) for Group 5 was *Institutional Controls with Monitoring and Contingent Remediation (Alternative 2B).* The Record of Decision also specified two remedial action objectives for the aquifer: (1) "Prior to 2095, prevent current on-site workers and general public from ingesting SRPA groundwater that exceeds a cumulative carcinogenic risk of 1×10^{-4}, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)" and (2) "In 2095 and beyond, ensure that SRPA groundwater does not exceed a cumulative carcinogenic risk of 1×10^{-4}, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)." The first remedial action objective is being met by maintaining institutional control over the area of the identified SRPA contaminant plume south of the current INTEC security fence for as long as contaminant levels remain above groundwater standards or risk-based groundwater concentrations. Groundwater monitoring and modeling have been performed to address the second remedial action objective (post-2095 risk).

Groundwater contaminant transport modeling performed in 1997 and revised in 2000 had predicted that elevated concentrations of 1-129 and Sr-90 could possibly persist after 2095 in the low-hydraulic-conductivity HI sedimentary interbed south of INTEC (between the "H" and "I" basalt flows). However, groundwater quality data were not available for the HI interbed downgradient of INTEC to verify the presence or absence of contaminants in the interbed, or the physical properties of the interbed sediments themselves.

In order to fill this data gap, a plume evaluation (HI interbed) investigation was performed during July–November 2002. The field investigation included the following: (1) drilling of four new borings (ICPP-1795 through ICPP-1798) through the HI interbed; (2) collection of samples from above, within, and below the HI interbed for laboratory analysis of groundwater; and (3) collection of interbed sediment samples for analysis of geotechnical properties.

Based on the field and laboratory results of the HI interbed investigation, the groundwater contaminant transport model was revised. The model also included a revised estimate of the 1-129 source term at the former INTEC injection well based on process knowledge. Appendix D contains an Engineering Design File report that documents the basis for the revised 1-129 source term. The revised model output more closely resembles the radionuclide contaminant plumes that currently exist in the aquifer.

Groundwater monitoring results for monitor wells located downgradient (south) of INTEC were reviewed and summarized. These results show that, as of 2003, tritium and 1-129 activities are already below their respective maximum contaminant levels (MCLs) in all SRPA monitor wells downgradient of INTEC. The 1-129 groundwater plume has diminished considerably in both areal extent and in peak concentration over the period between 1986 and 2003. Coupled with the modeling results, the observed dissipation of the 1-129 plume over the past 2 decades indicates that the remedial action objectives for this will be met before 2095.

Currently, Sr-90 activities in the aquifer exceed the MCL downgradient of INTEC, but Sr-90 concentrations are slowly declining in nearly all wells as a result of radioactive decay and dilution/dispersion. Groundwater quality trends indicate that Sr-90 activities in groundwater outside the INTEC security fence will decline below the MCL by 2095. However, perched water and vadose zone materials near the tank farm constitute a residual secondary source of Sr-90 that will be investigated and addressed under Operable Unit 3-14.

The remedy for Group 5 specified in the Record of Decision *(Institutional Controls with Monitoring and Contingent Remediation)* is operational and functional. Institutional controls are currently in place, and groundwater monitoring is being performed to ensure that the remedial action objectives for the aquifer are met. In addition, the infiltration of water through contaminated soils is being reduced in accordance with the Group 4 remedy *(Institutional Controls with Aquifer Recharge Control).*

Based on the decision logic established for Group 5, as well as the results of the plume evaluation field investigation, there is no need to invoke the contingent remedy (groundwater pump and treat). Furthermore, the results of groundwater sampling across the HI interbed have obviated the need for additional investigations (e.g., pumping tests, treatability studies), and the path forward for Group 5 consists of periodic plume monitoring. Both the groundwater monitoring results and the revised groundwater flow model presented in this report demonstrate that the 1-129 hot spot that had previously been predicted in the HI interbed downgradient of INTEC most likely does not exist. Concentrations of all Group 5 radionuclide contaminants of concern are declining in the aquifer. Therefore, there is no reason to believe that the Group 5 remedy will not be successful in achieving the remedial action objectives established in the Record of Decision.

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TABLES

ACRONYMS

AA	alternative action
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFA	Central Facilities Area
COC	contaminant of concern
CPP	Chemical Processing Plant
DOE	Department of Energy
DQO	data quality objective
DS	decision statement
EDF	Engineering Design File
EPA	Environmental Protection Agency
FFA/CO	Federal Facility Agreement and Consent Order
FY	fiscal year
HLWE	high-level waste evaporator
ICDF	INEEL CERCLA Disposal Facility
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LTMP	long-term monitoring plan
MCL	maximum contaminant level
MD	mean difference
MDA	minimum detectable activity
OU	operable unit
PSQ	principal study question
PVC	polyvinyl chloride
RAO	remedial action objective
RG	remediation goal

RI/BRA	remedial investigation/baseline risk assessment
RI/FS	remedial investigatiodfeasibility study
RMS	root mean square
ROD	Record of Decision
W D	relative percent difference
RWMC	Radioactive Waste Management Complex
SPERT	Special Excursion Reactor Test
S W A	Snake River Plain Aquifer
TAN	Test Area North
TBD	to be determined
TRA	Test Reactor Area
USC	United States Code
USGS	United States Geological Survey
WAG	waste area group
WCF	Waste Calcining Facility

Monitoring Report/Decision Summary for Operable Unit 3-13, Group 5, Snake River Plain Aquifer

1. INTRODUCTION

This Monitoring Report/Decision Summary serves as the remedial action report for Operable Unit (OU) 3-13, Group 5, Snake fiver Plain Aquifer (SRPA) at the Idaho Nuclear Technology and Engineering Center (INTEC), located at the Idaho National Engineering and Environmental Laboratory (INEEL) near Idaho Falls, Idaho. The remedial action report is a required submission under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 USC § 9601 et seq.) and is intended to assess the effectiveness of the selected remedial action for the SRPA groundwater contaminant plume associated with past operations at INTEC.

The INEEL is a U.S. Government-owned facility managed by the U.S. Department of Energy (DOE). The eastern boundary of the INEEL is 52 km (32 mi) west of Idaho Falls, Idaho. The INEEL Site occupies approximately 2,305 km^2 (890 mi^2) of the northwestern portion of the Eastern Snake fiver Plain in southeast Idaho. The INTEC facility covers an area of approximately 0.39 km^2 (0.15 mi^2) and is located approximately 72.5 km (45 mi) from Idaho Falls, in the south-central area of the INEEL (Figure 1-1). The INTEC has been in operation since 1952. Research, storage of spent nuclear fuel, and reprocessing spent nuclear fuel from defense-related projects for the recovery of enriched uranium were the plant's original missions. The DOE phased out the reprocessing operations in 1992 and redirected the plant's mission to (1) receive and temporarily store spent nuclear fuel and other radioactive waste for future disposition, (2) manage current and past waste, and (3) perform remedial actions.

Groundwater within the SRPA became contaminated as a result of past operations at the INEEL. Contaminant sources at INTEC include the former injection well that previously received low-level radioactive aqueous waste from plant processes (service waste), the former percolation ponds, and downward percolation of water through contaminated soil at the INTEC tank farm, where high-level liquid waste historically has been stored. The nature and extent of groundwater contamination downgradient of INTEC have been investigated for nearly 50 years, most recently as part of the CERCLA process. With respect to groundwater quality, the principal contaminants of concern (COCs) are radionuclides, including tritium, Sr-90, and I-129. Detailed information regarding previous groundwater investigations can be found in the *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part A, RI/BRA Report (Final)* (DOE-ID 1997) and the *Final Record of Decision Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13* (DOE-ID 1999).

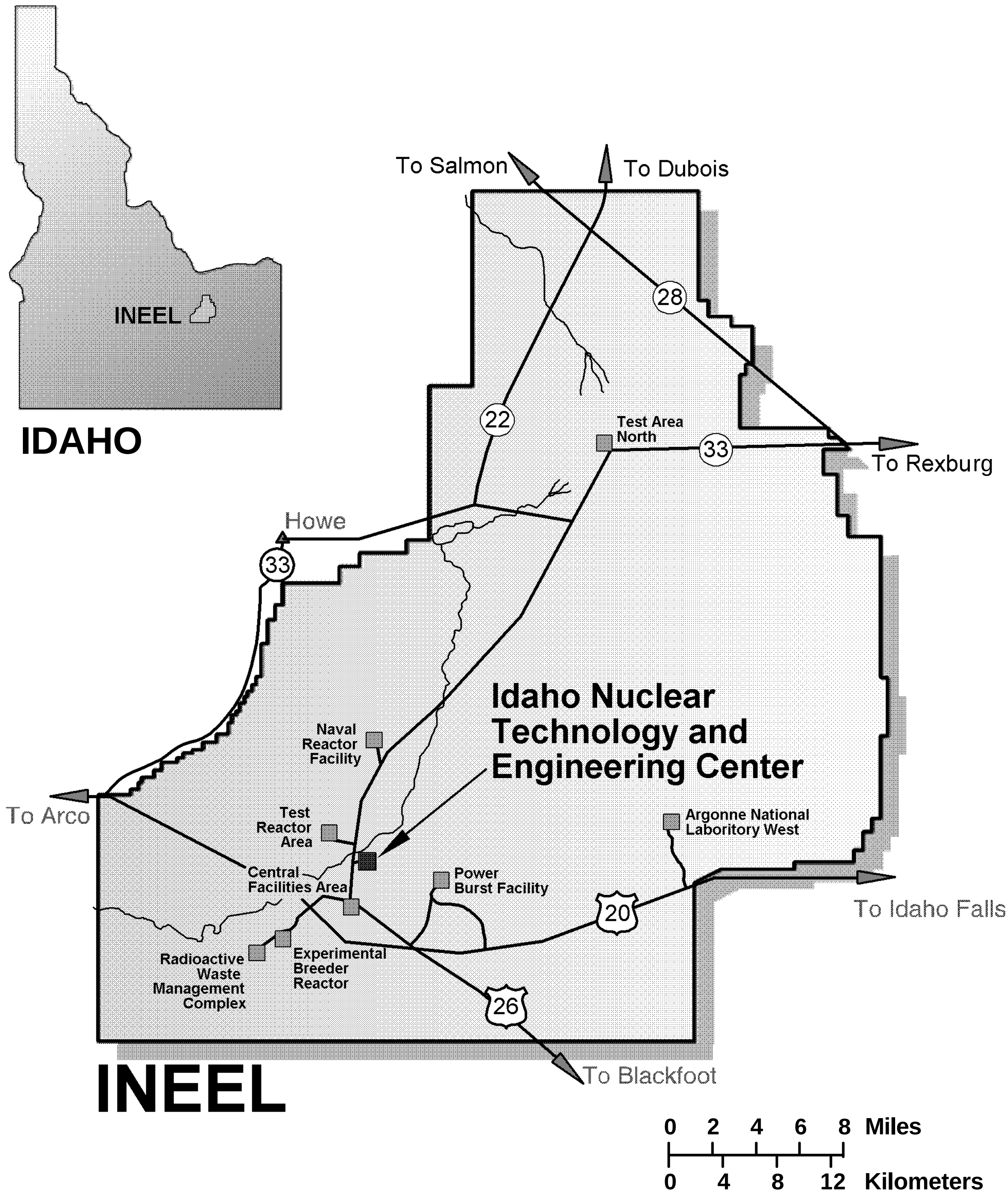


Figure 1-1. Map showing location of the INTEC at the INEEL.

2. REGULATORY BACKGROUND AND HISTORY

Under the *Federal Facility Agreement and Consent Orderfor the Idaho National Engineering Laboratory* (DOE-ID 1991), the U.S. Environmental Protection Agency (EPA), the Idaho Department of Environmental Quality, and the DOE (collectively known as the Agencies) are directing cleanup activities to reduce human health and environmental risks to acceptable levels at INTEC. In accordance with the Federal Facility Agreement and Consent Order (FFA/CO) (DOE-ID 1991), INTEC is designated as Waste Area Group (WAG) 3. In order to facilitate remediation of INTEC, WAG 3 was further divided into OUs that consist of individual contaminant release sites. The comprehensive remedial investigation/feasability study (RI/FS) for the INTEC facility was designated as OU 3-13, and the SRPA constitutes Group 5 of OU 3-13.

2.1 Remedial Action Objectives

The OU 3-13 Record of Decision (ROD) (DOE-ID 1999) evaluated various potential remedial actions for the SRPA, and, based on this assessment, the remedy selected for Group 5 was *Institutional Controls with Monitoring and Contingent Remediation (Alternative 2B).* The ROD specified two remedial action objectives (RAOs) for the aquifer outside the INTEC security fence: (1) "Prior to 2095, prevent current on-site workers and general public from ingesting SRPA groundwater that exceeds a cumulative carcinogenic risk of 1×10^{-4}, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)" and (2) "In 2095 and beyond, ensure that SRPA groundwater does not exceed a cumulative carcinogenic risk of 1×10^{-4}, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)."

The general actions required to meet the RAOs (post-2095) are spelled out in the OU 3-13 ROD (DOE-ID 1999). As stated in the ROD, the selected remedy (institutional controls with monitoring and contingent remediation) consists of three components:

- Maintaining existing and additional institutional controls over the area of the SRPA contaminant plume to prevent exposure to contaminated groundwater during the time the aquifer is expected to remain above maximum contaminant levels (MCLs)

- Groundwater monitoring to determine if SRPA groundwater COC concentrations exceed their action levels and if the impacted portion of the aquifer is capable of producing more than 0.5 gpm, which is considered the minimum drinking water yield necessary for the aquifer to serve as a drinking water supply

- Contingent active pump and treat remediation if the action levels are exceeded and production is greater than 0.5 gpm such that the modeled aquifer water quality will exceed the MCLs after 2095 in the SRPA outside the current INTEC security fence.

An interim action is selected for the SRPA. While the remediation of contaminated SRPA groundwater outside of the current INTEC security fence is final, the final remedy for the contaminated portion of the SRPA inside of the INTEC fence line is deferred to OU 3-14. As a result of dividing the SRPA, the groundwater contaminant plume associated with INTEC operations into two zones, the remedial action for OU 3-13 Group 5 is classified as an interim action. As required under CERCLA (42 USC § 9601 et seq.), 5-year reviews will be conducted until the Agencies determine they are no longer necessary. The 5-year reviews will evaluate the effectiveness of the selected remedial alternative or the need for the contingent remedial alternative.

2.2 Remediation Goals

Based on the RAOs, the OU 3-13 ROD (DOE-ID 1999) also established numerical remediation goals (RGs) for specific COCs in groundwater. The RGs for INTEC-derived COCs in groundwater outside the INTEC security fence are based on the applicable State of Idaho groundwater quality standards. The COCs listed in the OU 3-13 ROD (DOE-ID 1999) as having the potential to exceed groundwater standards after 2095 include Sr-90, 1-129, and tritium. The post-2095 RGs for these beta-gamma-emitting radionuclides are established as the drinking water MCLs. The RGs (MCLs) and half-lives for these COCs are as listed in Table 2-1.

Table 2-1. Snake River Plain Aauifer remediation goals

COC	Half-life (years)	SWA Remediation Goals[a] for Single COCs (pCi/L)
Tritium	12.3	20,000
Sr-90	29.1	**8**
1-129	15,700,000	1[b]

a. If multiple contaminants are present, use a sum of the fractions to determine the combined COCs' remediation goals. The total of beta-gamma-emitting radionuclides shall not exceed a 4-mrem/yr effective dose equivalent.

b. Derived concentration assuming COC is the only beta-gamma radionuclide present.

COC = contaminant of concern
SRPA = Snake fiver Plain Aquifer

2.3 Identification of Potential I-129 Hot Spot in HI Interbed

Two previous groundwater modeling efforts were performed prior to this report. Additional details regarding previous modeling efforts are included in Section 5 of this report and are summarized briefly below.

Groundwater modeling was performed in 1997 to assess whether the SWA remediation goals would be predicted to be met by 2095. The results of this first groundwater modeling effort are summarized in the Remedial Investigation/Baseline Risk Assessment (RI/BRA) (DOE-ID 1997, Appendix F). The results of the RI/BRA modeling predicted that elevated concentrations of 1-129 and Sr-90 might still remain in the low-hydraulic-conductivity HI sedimentary interbed. At that time, however, groundwater quality data were not available for the HI interbed downgradient of INTEC to verify the presence or absence of contaminants in the interbed.

The OU 3-13 RI/BRA aquifer model was updated during OU 3-13 Group 5 remedial actions (DOE-ID 2000). The aquifer model update attempted to more accurately simulate the HI interbed and the deep aquifer, and it also corrected a coding error in the earlier version of the computer code. Although the revised model predicted lower 1-129 activities in the SWA in the year 2095 than the previous RI/BRA model, the revised modeling results still showed the potential for 1-129 concentrations to exceed the MCL of 1 pCi/L within the low-permeability HI interbed sediments. At that time, data were not yet available regarding groundwater quality within the HI interbed and the physical properties of the interbed sedimentary materials.

3. PLUME EVALUATION FIELD INVESTIGATION

In order to address the HI interbed data gaps discussed above, a drilling and sampling investigation was performed during 2002 to collect information that had been lacking on the HI interbed, and groundwater quality above, within, and below this horizon. The investigation was performed according to the *Plume Evaluation Field Sampling Plan for Operable Unit 3-13, Group 5, Snake River Plain Aquifer* (DOE-ID 2002a) and included drilling and sampling of four borings downgradient of INTEC. Locations of the four borings are shown in Figure 3-1. As detailed in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a), decision criteria were established based on the results of vertical groundwater quality profiling in the four boreholes.

3.1 Data Quality Objectives

Data quality objectives (DQOs) developed for the HI interbed investigation were presented in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a) and are reproduced here in Table 3-1. The DQO table outlines the principal study questions (PSQs), decision statements, and inputs to the decisions that support the Group 5 contingent remedy decision.

The decision logic for this investigation is shown schematically in Table 3-1. The flowchart outlines the steps to be taken to arrive at a contingent remedy decision and to perform the SRPA interim monitoring. These two separate flow paths are identified on the chart. As shown on the left portion of the flowchart, the results of the field investigation described in this section determine the need for additional investigations (e.g., pumping tests, treatability studies), as well as the decision of whether to implement the contingent Group 5 remedy.

3.2 Field Investigation

The OU 3-13, Group 5 Plume Evaluation (HI interbed) Investigation included four new borings (ICPP-1795 through ICPP-1798) drilled to investigate groundwater quality above, within, and below the HI interbed, and to collect samples of the interbed materials for analysis of geotechnical properties. Boring locations are shown on Figure 3-1. The locations were selected based on the results of 1-129 contaminant transport modeling (DOE-ID 2002a). Drilling operations began on July 18, 2002, and drilling and sampling were completed on November 14, 2002. Following is a summary of field activities and investigation results. Appendix A includes "End-of-Well Reports" that contain additional details of drilling and well construction activities.

3.2.1 Interbed Sampling Methods

Sediment core samples were collected from the HI interbed for geophysical and chemical analysis. An attempt was made to collect samples from the top, the center, and from the bottom of the interbed at each of the four boring locations. Additional interbed samples were collected from the ICPP-1798 borehole because of the greater thickness encountered at this location.

The HI interbed was cored with an "H" or "P" sized diamond-impregnated, face discharge core bit using water as a drilling fluid. The core barrel was lined with an appropriate sized Lexan liner for the bit size being used. The Lexan liner and sediment sample were recovered with a wireline system, and the core samples were cut into 6-in. lengths, sealed, and submitted to the laboratory for geophysical testing. In addition, a subsample of the interbed sedimentary material collected from the interior of the core sample was placed into proper sample containers for submittal to the analytical laboratories for chemical analysis as specified in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a).

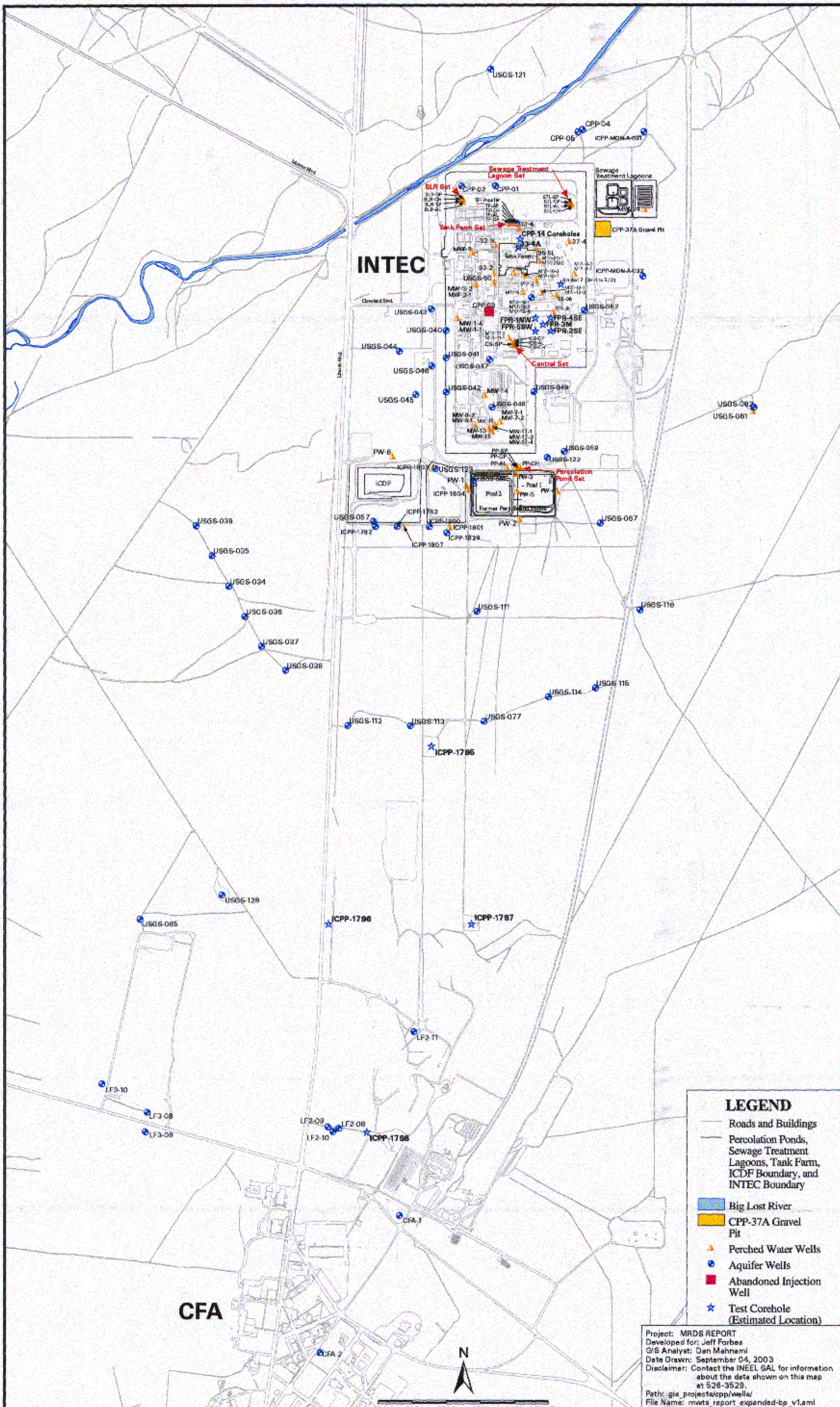


Figure 3-1. Location of monitor wells and borings.

Table 3-1. Data aualitv objectives table. Operable Unit 3-13. Group 5. Snake River Plain Aauifer.

Problem Statement A: HI Intert 1 Contingent Remedy Decision					
1. State the Problem	2. Identify the Decision			3. Identify Inputs to the Decision	4. Define the Study Boundaries
<u>Problem Statement A</u>: Empirical data are required to support evaluation of the WAG 3 SRPA numerical model to determine if we continue to predict a risk to future groundwater users in 2095 and beyond due to 1-129 potentially present in the HI sedimentary interbed. Note: Modeling of the SRPA for the WAG 3 RIES predicted a future risk to groundwater users due to high concentrations of 1-129 predicted to be present in the low-hydraulic-conductivity HI sedimentary interbed in the year 2095 and beyond. However, no empirical data are available to confirm the physical properties of the HI interbed as assumed in the WAG 3 model nor are there any data regarding the presence or absence of high concentrations of 1-129 in the interbed. Empirical evidence is required to evaluate the model predictions and determine whether or not an acceptable risk from 1-129 is predicted to exist in 2095 and beyond.	Principal Study Questions	Alternative Actions	Decision Statement		This study will focus on physical characteristics of the HI sedimentary interbed and peak concentrations and distribution of groundwater COCs within the SRPA groundwater contaminant plume south of INTEC. The purpose of the study is to determine if the WAG 3 RIES aquifer model is correct in predicting that there will be an unacceptable risk to residential groundwater users outside of the WTEC fence line in excess of 1×10^{-4} (or COCs exceeding MCLs) in the year 2095 and beyond. The potential risk is primarily from 1-129, which is predicted by the aquifer model to reside in the HI interbed at concentrations exceeding the RG. The spatial boundary of this study is limited to the area defined as Group 5, SRPA, under the OU 3-13 ROD (DOE-ID 1999). This encompasses that portion of the SRPA outside of the INTEC security fence bounded by the groundwater contaminant plume that exceeds Idaho groundwater quality standards of the federal MCLs for 1-129, H-3, or Sr-90. Based upon the WAG 3 groundwater model, the area of particular interest within this boundary is an 1-129 hot spot south of INTEC in the vicinity of Well USGS-113. (Note: This may be refined by prefield testing sensitivity analysis of HI interbed in the WAG 3 aquifer model.) The estimated depth of the HI interbed in this area is between 100 and 140 ft below the water table, though the aquifer above, within, and below the HI interbed is included in this study. The base of the study area will be the first high permeability zone in the I basalt below the HI interbed, but not to exceed 100 ft below base of HI interbed. The hot spot is predicted to exist within the HI sedimentary interbed below the water table at this location. However, to date, empirical evidence has not been collected that supports the existence of this hot spot, nor has a sensitivity analysis been performed on the WAG 3 model's representation of the HI interbed that resulted in the prediction. It should be noted that practical constrains on the collection of soil and groundwater samples (i.e., poor sample recovery, limitation on packer deployment in rubble, or cavernous zones) may limit our ability to sample the interbed or SRPA in general at certain zones. This study will be used to determine if contingent groundwater remediation is required to reduce the risk to future groundwater users in the year 2095 and beyond. Thus, the current decision of whether to implement the contingent remedy will rely on predicted concentrations of COCs, as calculated by the refined WAG 3 aquifer model. Institutional controls will be in place before 2095 to prevent residential use of groundwater exceeding MCLs or 1×10^{-4} risk concentrations.
	PSQ-1: Are COC concentration action levels exceeded in the model-predicted hot spot of the groundwater contaminant plume outside of the WTEC security fence? Note: The action level(s) is based on groundwater modeling and will correspond to COC concentrations that will not exceed risk concentrations greater than 1×10^{-4} or MCLs in the year 2095. The COC concentration data will be obtained from the HI interbed and surrounding basalts during the field-sampling program anticipated to occur in FY 2001. Modeling predictions are required to determine if these action levels will be exceeded in 2095. The combined COC action level for H-3, Sr-90, and 1-129 (beta-gamma-emitters) is 4 mrem/yr in the year 2095.	AA-1: Alternatives to PSQ-1 include proceeding to actions required to answer PSQ-3 or lapsing into SRPA monitoring.	DS-1: Determine whether COC concentration action levels are exceeded in the model-predicted hot spot downgradient of INTEC requiring additional evaluation of the aquifer water yield from the hot spot.	The following are inputs to PSQ-1: 1. Groundwater model sensitivity analysis of the HI sedimentary interbed characteristics, to identify key variables, related to HI interbed for long-term predictions of COC concentrations 2. Establishing four new wellshoreholes in the 1-129 hot spots for groundwater and sedimentary interbed sampling 3. Physical characteristics of the HI sedimentary interbed (TBD will be identified in the aquifer model sensitivity analysis) to support model refinement and COC concentration predictions 4. Borehole geophysical and fluid logging of new wells for location of sampling depths 5. Vertical profile sampling (straddle packer) of new wellshoreholes and existing wells for COC concentrations at, above, and below the HI interbed 6. One sampling round of 47 aquifer monitoring wells for 1-129, H-3, and Sr-90 to support model refinement and COC concentration predictions 7. Model refinement and updated prediction of COC concentrations in 2095 and beyond.	
	PSQ-2: Do zones, whch exceed COC action levels identified in PSQ-1, yield a sustained flow of greater than 0.5 gpm for a period of 24 hours?	AA-2: Alternatives to PSQ-2 included proceeding to actions required to answer PSQ-3 or lapsing into SRPA monitoring.	DS-2: Determine if the hot spot will yield a groundwater flow rate of 0.5 gpm for a period of 24 hours.	If the COC action levels are exceeded in PSQ-1, then the following will be inputs to PSQ-2: 1. A 24-hour/0.5-gpm pumping test(s) of the zones that were identified in PSQ-1 as having COC(s) exceeding action level(s) 2. Sampling of the COC(s) during the pumping test.	
	PSQ-3: Does the hot spot exceed the volume-action level such that a residential water user may pump from the hot spot for a period of more than 1 year?	AA-3: Alternatives to PSQ-3 include proceeding on to the contingent remedy and aquifer monitoring or just lapsing into SRPA monitoring.	DS-3: Determine if the hot spot is of sufficient size/volume to require contingent remediation.	If required, the following will be inputs to PSQ-3: 1. An analytical or model-derived volume action level 2. Evaluation of the COC hot spot volume through the creation of iso-surface maps to calculate the estimated volume.	

Table 3-1. (continued).

Problem Statement A: HI Interbed Contingent Remedy Decision		
5. Develor, a Decision Rule	6. Specify Tolerable Limits on Decision Errors	7. Optimize the Design
DS-1: If any COC exceeds its action level at any sampling zone, then we must determine if the aquifer at that zone is also capable of producing a sustained yield of 0.5 gpm for a period of 24 hours. If COC action levels are not exceeded at any sampling location then we will proceed With SRPA monitoring (i.e., periodic monitoring).	TBD	A flow chart presenting the conceptual design of the WAG 3, Group 5, field activities is attached as Figure 3-2 titled, "Structure map showing the top of the HI interbed." The flow chart details the steps to be taken to both arrive at a contingent remedy decision and to perform the SRPA interim monitoring. The two separate flow paths are identified on the chart. The following paragraphs describe and present the rationale for the design of field activities related to the contingent remedy decision. The Group 5 decision to collect additional COC concentrations, and SRPA and interbed data before makmg a decision on implementation of the contingent remedy, is based on the need to evaluate the WAG 3 RI/FS model predictions of elevated 1-129 concentrations in the SRPA, including the HI interbed, in 2095 and beyond. Because no physical characteristics or COC concentration data were available from the HI interbed to confirm the model predictions, and no sensitivity analysis has been performed, we must collect empirical data on the presence of 1-129 in the SRPA and physical properties of the HI interbed south of INTEC to support refinement of the groundwater model. Given the basis for the field activities, before conducting the field activities, available field data will be reviewed and a sensitivity analysis on the HI interbed assumptions will be performed. This activity will be performed to identify hydrologic data gaps, which Will be incorporated in the final sampling and analysis plan for the Group 5 contingent remedy decision. Based upon the RIES hot spot modeling and the Monitoring System and Installation Plan (DOE-ID 2003a) hot spot modeling, four additional wellshoreholes Will be constructed. The wells Will be drilled in a manner that allows for the collection of sedimentary interbed samples from the HI interbed for analysis of physical characteristics and COC concentrations. Following drilling, borehole geophysical and fluid logging will be performed on the newly deepened and constructed wells (and three existing wells selected for profiling) to identify sampling locations for COC vertical profile sampling. The geophysical logging will consist of natural gamma, caliper, deviation, and video logging. Borehole fluid logging will consist of borehole flow, temperature, and specific conductivity. These logs will be reviewed before groundwater sample collection to identify the specific zones within each borehole for sampling. Groundwater sampling will be conducted using a packer system and sampling pump to isolate the specific zone being sampled. Except for the interbed sample, one sample Will be collected from each sampling zone. Because of concerns about borehole collapse or sloughing in the interbed, groundwater samples from the interbed Will be collected during drilling. The borehole will be extended approximately 5 ft into the interbed and the first sample will be taken using a single packer system and will consist of packing off the basalt at the interbed basalt interface. A bottom packer Will not be used for interbed sampling. To guard against equipment getting trapped in the hole, the pump Will be placed above the packer and a screen placed below the packer in the interbed. Replicate samples for Tc-99 and 1-129 will be collected during interbed sampling. The replicate Tc-99 samples will be analyzed and the replicate 1-129 sample held in storage until the results are determined for the 1-129 and Tc-99 samples. The replicate samples Will be analyzed for Tc-99 to confirm the original sample results. If 1-129 is above the action level, the replicate 1-129 sample from the interbed will be analyzed. Following sample collection and analysis, the data will be reviewed to determine if the COC action levels are exceeded in any sampling zone. If the COC action level is exceeded in a zone, the zone Will again be isolated with packers and pumped for a period of 24 hours to determine if the zone will yield groundwater at a rate of 0.5 gpm for the duration of the test. One water sample will be collected every 4 hours during pumping to determine if the COC action levels also are exceeded throughout the pumping test. If COC action levels are exceeded and the aquifer at the sampling zone(s) yields a sustained 0.5 gpm for a 24-hr period, isopleth maps will be developed from the COC concentration data to estimate the volume of the hot spot(s). It is possible that additional wells may be required to estimate the hot spot volume. If additional wells are determined necessary, they will be drilled and then tested in the same manner as described above. The final volume estimates will be compared to the model-derived volume action level to determine if it has been exceeded. These results will be reported in the Group 5 Monitoring Report/Decision Summary. To assist in the model evaluation and COC predictions discussed above, and to up date information on COC plume dynamics subsequent to the 1991 USGS sampling event, samples Will be collected from the existing aquifer monitoring well network and analyzed for COC concentrations. This sampling Will provide additional data to support model predictions of how the aquifer is performing outside of the HI interbed and support refinement of the model predictions. A first round of sampling will be performed, including the full INTEC monitoring network (47 wells), with subsequent annual monitoring performed on a limited set of wells (approximately 20) specifically identified to support an updated aquifer model calibration. Following completion of the Monitoring Report/Decision Summary, periodic monitoring of the WAG 3 groundwater plume(s) outside of the INTEC security fence line Will be implemented. This periodic monitoring of the plumes will be performed concurrent with the INTEC facility monitoring.
DS-2: If the aquifer is capable of producing 0.5 gpm for a period of 24 hours from a zone, which also exceeds COC action levels, then we must determine the volume of the hot spot. If the zone does not produce 0.5 gpm for 24 hours then we Will proceed with SRPA monitoring.		
DS-3: If the volume of the COC hot spot is sufficiently large that a future groundwater user could pump from the hot spot for a period of more than 1 year, then we are required to proceed With the contingent remedy. If the hot spot does not exceed the volume action level, then we will proceed With SRPA monitoring.		

AA = alternative action
COC = contaminant of concern
DS = decision statement
FY = fiscal year
INTEC = Idaho Nuclear Technology and Engineering Center
MCL = maximum contaminant level
OU = operable unit
PSQ = principal study question
RG = remediation goal
RIES = remedial investigatiodfeasibility study
ROD = Record of Decision
SRPA = Snake fiver Plain Aquifer
TBD = to be determined
USGS = United States Geological Survey
WAG = waste area group

3.2.2 Results for HI Interbed Soil Samples

A total of 13 HI interbed soil samples were analyzed to determine the activities of selected radionuclides, as well as for geotechnical properties. The results of these laboratory tests are summarized below.

The HI interbed samples collected during the plume evaluation investigation were analyzed for tritium, Sr-90, I-129, as well as gross alpha and gross beta radiation. Table 3-2 lists the sample depths at each boring location and the laboratory analytical results for each sample. Based on the laboratory results, key findings for soil samples are as follows:

- Iodine-129 was not detected in any of the soil samples. All results were qualified with "U" or "UJ" flags at minimum detectable activity (MDA) values ranging from 0.25 to 0.36 pCi/g.
- Tritium was not detected in any of the soil samples (all results qualified with "U" flags at MDA values ranging from 3.9 to 19.5 pCi/g).
- Strontium-90 was not detected in any of the soil samples (all results qualified with "U" or "UJ" flags at MDA values ranging from 0.14 to 0.29 pCi/g).

3.2.3 HI Interbed Structure

Table 3-3 shows the depth and thickness of the HI interbed at each borehole location. Figure 3-2 is a structure map showing the elevation of the top of the HI interbed near INTEC, and Figure 3-3 is an isopach map of the HI interbed thickness. In general, the interbed elevation decreases to the southeast, and interbed thickness increases toward the southeast. The thickness of the HI interbed ranges from zero at some locations directly beneath INTEC to 65 ft at USGS-20, which is located approximately 8,000 ft southeast of the INTEC southern boundary (Figure 3-3).

3.2.4 Geotechnical Properties of HI Interbed Sediments

Daniel B. Stephens & Associates, Inc. performed the geotechnical analyses of the sediment core samples from Boreholes ICPP-1795 through ICPP-1798. The samples were analyzed for porosity, hydraulic conductivity, and grain size distribution. The results of these analyses will be used to refine the OU 3-13 RI/FS groundwater flow model (Section 5 and Appendix B). Results of the geotechnical tests are shown in Table 3-4. Because the split-barrel sampler was incapable of obtaining core samples of some of the gravelly interbed sediments encountered in the boreholes, the finer-grained interbed material was preferentially sampled. Therefore, it is likely that the hydraulic conductivities shown in Table 3-4 are biased low.

Daniel B. Stephens & Associates, Inc. also assigned American Society for Testing and Materials and United States Department of Agriculture soil classifications for the sediment samples. These soil classifications, as well as the United Soil Classification symbols inferred from the laboratory data, are listed in Table 3-5.

Table 3-2. Soil chemistry.

Location	Depth (ft)	Sample Number	Date Sample Collected	Gross Alpha				Gross Beta				Iodine-129				Tritium				Sr-90			
				Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)
ICPP-1795 WT-1	588.0–588.7	5HI06201	09/03/2002	19.50	3.23	—	5.39	48.80	1.21	J	3.74	0.00	0.05	UJ	0.29	-0.19	1.26	U	4.28	0.05	0.07	U	0.29
ICPP-1795 WT-2	591.9–592.3	5HI06301	09/03/2002	21.40	2.93	—	3.93	30.10	0.97	J	2.82	0.11	0.05	UJ	0.31	-0.45	1.14	U	3.90	0.01	0.06	U	0.28
ICPP-1796 WT-1	506.5–607.5	5HI01401	09/27/2002	8.42	2.24	—	6.40	21.60	1.15	—	7.75	0.08	0.08	UJ	0.36	-4.80	4.66	U	16.30	-0.01	0.06	U	0.29
ICPP-1796 WT-2	615–620	5HI01501	09/30/2002	13.70	2.51	—	4.10	31.40	1.41	—	7.11	0.23	0.06	UJ	0.33	-8.46	5.55	U	15.60	0.00	0.05	U	0.23
ICPP-1796 WT-3	626–628	5HI01601	09/30/2002	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.05	U	0.23
ICPP-1797 WT-1	605.0–605.5	5HI03001	10/16/2002	20.90	3.08	—	4.16	39.80	1.12	J	3.19	0.02	0.07	UJ	0.31	-2.53	1.39	U	4.88	-0.06	0.02	U	0.15
ICPP-1797 WT-2	607	5HI03101	10/17/2002	28.50	4.21	—	5.19	31.00	1.41	J	3.88	-0.05	0.06	UJ	0.25	-2.73	1.34	U	4.72	0.07	0.04	U	0.14
ICPP-1797 WT-3	614	5HI03201	10/17/2002	22.90	3.44	—	5.24	33.60	1.18	J	3.72	-0.03	0.04	UJ	0.27	-3.34	1.41	U	5.01	0.00	0.03	U	0.14
ICPP-1798 WT-1	520.5–622.0	5HI04601	9/11/2002	15.50	3.05	—	6.38	27.90	1.50	—	7.06	0.02	0.05	UJ	0.30	1.06	5.72	U	19.50	0.14	0.06	UJ	0.25
ICPP-1798 WT-2	626–628	5HI04701	9/18/2002	19.10	2.78	—	4.91	28.00	1.50	—	7.02	-0.09	0.07	UJ	0.31	3.83	4.34	U	14.50	—	—	—	—
ICPP-1798 WT-2 (lower)	636	5HI04701 (RB)	10/24/2002	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.08	0.04	UJ	0.15
ICPP-1798 WT-3	656	5HI04801	10/24/2002	14.00	2.59	—	4.42	27.30	1.05	J	3.33	-0.04	0.06	UJ	0.29	-3.30	1.42	U	5.03	0.11	0.04	UJ	0.15
ICPP-1798 WT-4	661	5HI14101	10/24/2002	17.50	3.09	—	5.91	32.60	1.08	J	3.76	0.06	0.05	UJ	0.29	-3.12	1.47	U	5.21	-0.02	0.03	U	0.14
ICPP-1798 WT-5	676	5HI14201	10/30/2002	25.30	4.19	—	6.23	52.50	1.30	J	3.37	-0.05	0.06	UJ	0.29	-4.18	1.27	U	4.59	0.00	0.03	U	0.14

ICPP = Idaho Chemical Processing Plant
MDA = minimum detectable activity

3.2.5 Aquifer Sampling Methods

Groundwater samples were collected from discrete depths within the SRPA in each of the four boreholes using an inflatable packer system. Groundwater sample depths are listed in Table 3-6. The configuration of the straddle-packer sampling system is shown in Figure 3-4.

Groundwater sample depths were selected based on review of geophysical logs (caliper, natural gamma, neutron, gamma-gamma, and temperature logs) and downhole video logs. Fracture zones were targeted for groundwater sampling, with tighter, more massive basalt zones above and below selected for the packer seal zones. In addition, two less productive zones were selected in the first borehole (ICPP-1797) to determine if massive basalt zones would produce sufficient groundwater for sampling and to test the effectiveness of the packer system seal against the borehole wall.

The groundwater sampling procedure at each sample depth was as follows. **A** Baski 3.4-in. uninflated packer was placed above and below the pump intake. **A** Grunfos Redi-Flo 3 pump was used with a single-phase 220-volt pump motor and field generator. The pump and packer system were lowered to the proper depth in the borehole on a l-in.-diameter galvanized steel pump riser pipe. The packers were then inflated with compressed nitrogen gas. The pump was then turned on, and the isolated portion of the borehole between the packers was purged at flow rates of 3.5 to 5 gal per minute, depending on pump depth. The sample interval between the two packers was purged of a minimum of three volumes of groundwater. Following purging of at least three sample interval volumes, groundwater samples were collected after the groundwater temperature had stabilized.

For those boreholes for which duplicate groundwater samples were required, the primary sample was collected first, and the duplicate sample was collected at the end of sampling. This enabled comparison of the results for samples collected at the beginning and the end of the sampling process.

Table 3-3. HI interbed depth and thickness

Borehole/Well Location	Depth of HI Interbed Below Surface (ft bls)	Elevation of Top of HI Interbed (ft)	Thickness of HI Interbed (ft)
ICPP-1795	587	4,340	7
ICPP-1796	605	4.33 1	27
ICPP-1797	601	4,328	16
ICPP-1798	621	4,315	57
USGS-128	612	4,323	35

ICPP = Idaho Chemical Processing Plant
USGS = United States Geological Survey

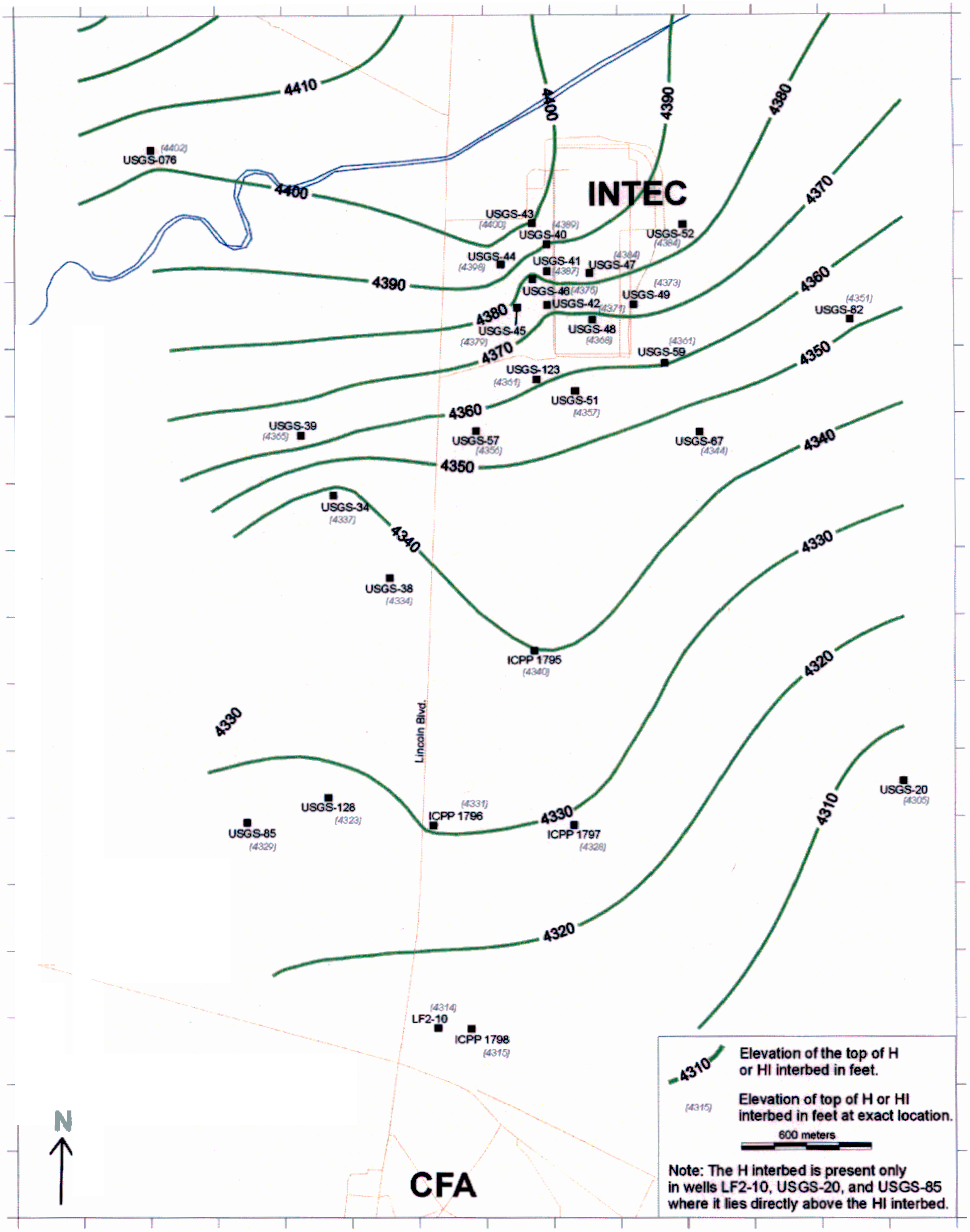


Figure 3-2. Structure map showing the top of the HI interbed.

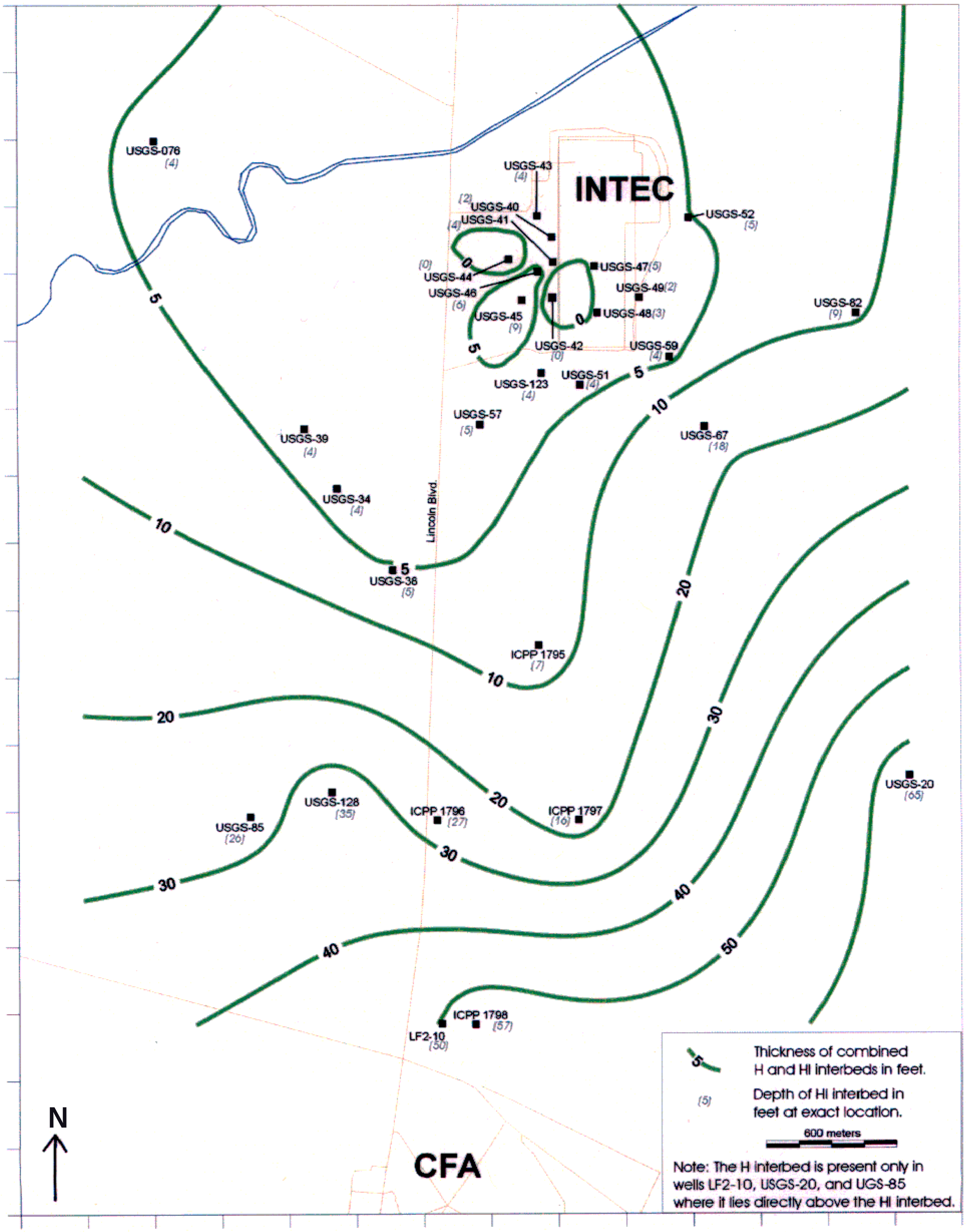


Figure 3-3. Isopach map showing the thickness of HI interbed.

Table 3-4. Geotechnical results for core samples of HI interbed.

Borehole Number	Sample Depth (ft)	Porosity (%)	K_{sat} (cm/sec)	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Sample Number	Date Collected
ICPP-1795	591.O–591.9	49.9	9.80E-08	0.00056	0.018	0.083	148	0.31	5HI06201GX	9/3/02
ICPP-1795	593.8–594.2	31.6	2.30E-07	0.00042	0.16	0.22	524	46	5HI06301GX	9/3/02
ICPP-1796	615–620	NA	NA	0.25	3.2	4.2	17	1.6	5HI01501GX	9/30/02
ICPP-1796	626–628	NA	NA	0.11	0.16	0.18	1.6	0.85	5HI01601GX	9/30/02
ICPP-1797	604–605	42.9	1.20E-02	0.12	0.28	0.32	2.7	0.94	5HI03001GX	10/16/02
ICPP-1797	607	NA	NA	0.18	5.1	6.5	36	0.43	5HI03101GX	10/17/02
ICPP-1797	614	33.8	8.30E-04	0.0012	0.16	0.31	258	1.3	5HI03201GX	10/17/02
ICPP-1798	621.O–621.5	NA	NA	0.0065	0.1	0.2	31	0.69	5HI04601GX	9/1 1/02
ICPP-1798	626–628	NA	NA	0.15	0.38	0.44	2.9	1.3	5HI04701GX	9/18/02
ICPP-1798	656	43.1	6.50E-05	0.0047	0.15	0.18	38	12	5HI04801GX	10/24/02
ICPP-1798	661	39.3	1.40E-03	0.12	0.3	0.38	3.2	0.79	5HI14101GX	10/24/02

$C_u = d_{60}/d_{10}$
$C_c = d_{30}^2/(d_{10})(d_{60})$
d_{50} = median particle diameter
K_{sat} = hydraulic conductivity
ICPP = Idaho Chemical Processing Plant
NA = sample not available, could not obtain undisturbed sample of coarse-grained material for analysis.

Table 3-5. Soil texture classification of HI interbed sediments.

Borehole Number	Sample Depth (ft)	American Society for Testing and Materials Classification	United States Department of Agriculture Classification	Unified Soil Classification System	Sample Number	Date Collected
ICPP-1795	591.O–591.9	Classification requires Atterberg test.	Loam (est)	ML	5HI0620 1GX	9/3/02
ICPP-1795	593.8–594.2	Classification requires Atterberg test.	Sandy loam (est)	**SC**	5HI06301GX	9/3/02
ICPP-1796	615–620	Poorly graded sand with gravel	NA	**SW**	5HI0 150 1GX	9/3/02
ICPP-1796	626–628	Poorly graded sand	Sand	SP	5HI0 1601GX	9/3/02
ICPP-1797	604–605	Poorly graded sand	Sand	SP	5HI03001GX	10/16/02
ICPP-1797	607	Poorly graded gravel with sand	NA	GP	5HI03 101GX	10/17/02
ICPP-1797	614	Classification requires Atterberg test.	Sandy loam (est)	**SC**	5HI03201GX	10/17/02
ICPP-1798	621.O–621.5	Classification requires Atterberg test.	Silty sand	SM	5HI0460 1GX	9/1 1/02
ICPP-1798	626–628	Poorly graded sand	Sand	SP	5HI0470 1GX	9/18/02
ICPP-1798	656	Classification requires Atterberg test.	Loamy sand	**SC**	5HI04801GX	10/24/02
ICPP-1798	661	Poorly graded sand with gravel	NA	SP	5HI14 10 1GX	10/24/02
ICPP-1798	676	Classification requires Atterberg test.	Silt loam (est)	ML	5HI14201GX	10/30/02

Est = reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was require to c tain the d_{10} diameter.
NA = not applicable

Table 3-6. Groundwater sampling intervals and depths.

Borehole	Sample Series Number	Sample Description	Depth to Bottom of Upper Packer (ft)	Depth to Top of Lower Packer (ft)	Length of Sampling Interval (ft)
ICPP-1795	5HI049	Zone 1	578.7	593.6	14.9
ICPP-1795	5HI050	Zone 2	558.1	573.0	14.9
ICPP-1795	5HI051—Dry	Dry	494.7	509.6	14.9
ICPP-1795	5HI051—Dry	Dry	511.8	526.7	14.9
ICPP-1795	5HI051—Dry	Dry	533.9	548.8	14.9
ICPP-1795	5HI058	Zone 10	608.4	623.3	14.9
ICPP-1795	5HI059	Above	558.1	573.0	14.9
ICPP-1795	5HI060	Below	608.4	623.3	14.9
ICPP-1795	5HI061	Within	578.7	593.6	14.9
ICPP-1796	5HI01	Zone 1	604.0	613.0	9
ICPP-1796	5HI02	Zone 2	a	487.0	a
ICPP-1796	5HI03	Zone 3	489.7	504.6	14.9
ICPP-1796	5HI04—Dry	Dry	516.0	530.9	14.9
ICPP-1796	5HI010	Zone 10	632.0	663.0	31
ICPP-1796	5HI011	Above	489.7	504.6	14.9
ICPP-1796	5HI012	Below	632.0	663.0	31
ICPP-1796	5HI013	Within	604.0	613.0	9
ICPP-1797	5HI017	Zone 1	589.3	604.2	14.9
ICPP-1797	5HI018	Zone 2	a	503	a
ICPP-1797	5HI019	Zone 3	506.3	521.2	14.9
ICPP-1797	5HI020	Zone 4	522.4	537.3	14.9
ICPP-1797	5HI021	Zone 5	551.6	566.5	14.9
ICPP-1797	5HI022	Zone 6	578.2	593.1	14.9
ICPP-1797	5HI026	Zone 10	629.0	b	b
ICPP-1797	5HI027	Above	a	503	a
ICPP-1797	5HI028	Below	629.0	b	b
ICPP-1797	5HI029	Within	589.3	604.2	14.9
ICPP-1798	5HI033	Zone 1	604.0	613.0	9
ICPP-1798	5HI034	Zone 2	a	507	a
ICPP-1798	5HI035	Zone 3	510.8	525.7	14.9
ICPP-1798	5HI036	Zone 4	527.9	542.8	14.9
ICPP-1798	5HI037	Zone 5	552.6	567.5	14.9
ICPP-1798	5HI038	Zone 6	573.2	588.1	14.9
ICPP-1798	5HI042	Zone 10	699.0	b	b
ICPP-1798	5HI043	Above	552.1	567.0	14.9
ICPP-1798	5HI044	Below	699.0	b	b
ICPP-1798	5HI045	Within	604.0	613.0	9

a. No upper packer was used. Sample zone is from the water table to the lower packer.

b. No lower packer was used. Sample zone is from the upper packer to the bottom of the well.

ICPP = Idaho Chemical Processing Plant

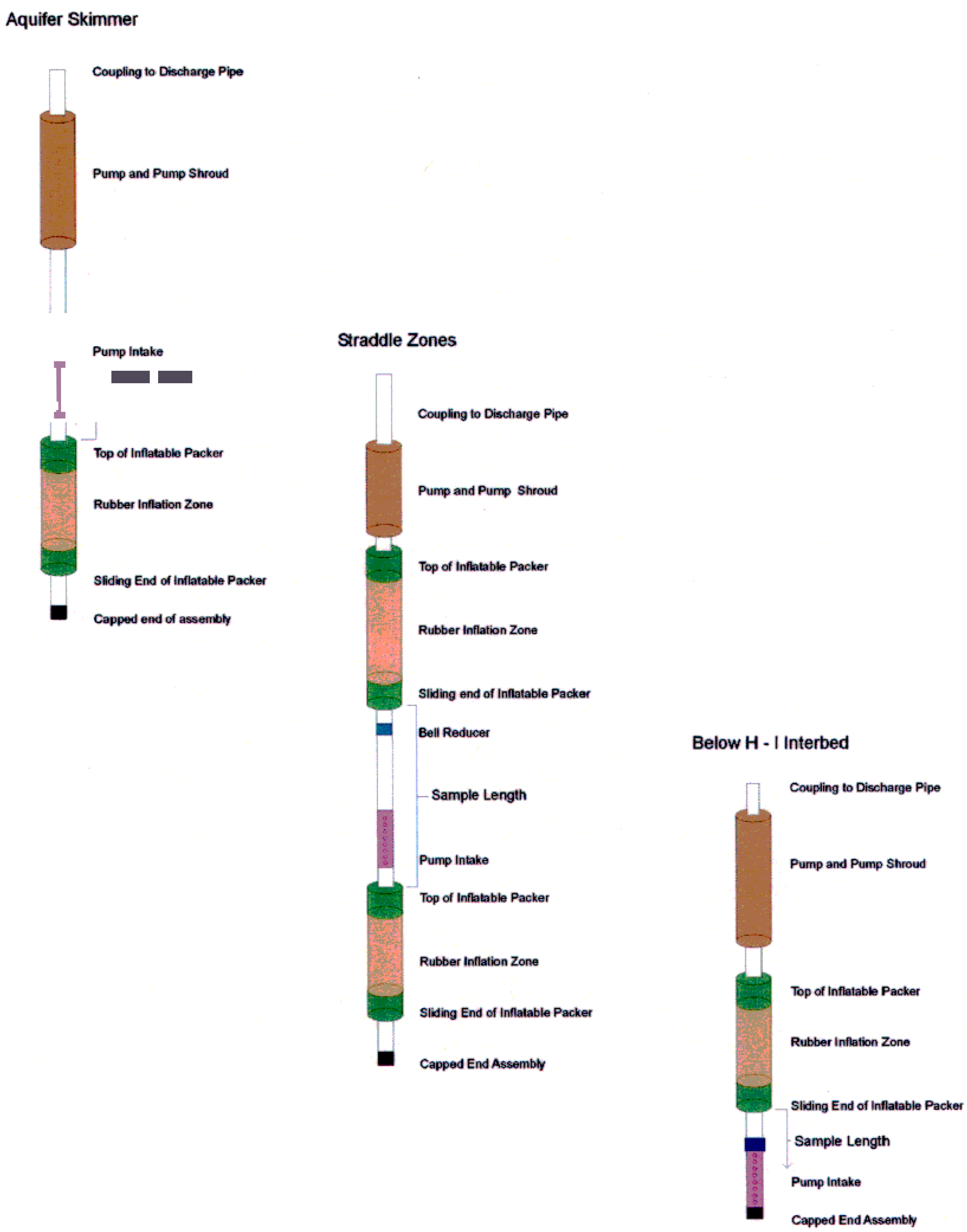


Figure. 3-4. Straddle packer and pump configurations.

3.2.6 Groundwater Sampling Results

The water samples collected from ICPP-1795, ICPP-1796, ICPP-1797, and ICPP-1798 were analyzed to determine the activities of tritium, Sr-90, I-129, and Tc-99, as well as gross alpha and gross beta radiation. Groundwater results are summarized in Table 3-7. Radionuclide depth profiles are shown in Figures 3-5 through 3-8. For each borehole, the depth profiles show the observed radionuclide activities in groundwater samples collected above, within, and below the HI interbed. Drinking water MCLs also are shown for comparison. Groundwater quality results for each radionuclide of concern are summarized below.

Table 3-7. Groundwater aualitv results.

Location	Depth (ft)	Zone	Sample Number	Date Sample Collected	1-129				Tc-99				Sr-90				Tritium			
					Result (pCi/L)	Result Uncertainty (+/- 1 sigma)	Qualifier Flag	MDA (pCi/L)	Result (pCi/L)	Result Uncertainty (+/- 1 sigma)	Qualifier Flag	MDA (pCi/L)	Result (pCi/L)	Result Uncertainty (+/- 1 sigma)	Qualifier Flag	MDA (pCi/L)	Result (pCi/L)	Result Uncertainty (+/- 1 sigma)	Qualifier Flag	MDA (pCi/L)
ICPP-1795	558–573	Z-2	5HI05001	10/9/02	0.59	0.36	U	0.72	—	—	—	—	3.72	0.50	—	0.59	11,100	317	—	445
ICPP-1795	558–573	Above interbed	5HI05901	10/9/02	0.34	0.04	—	0.14	6.95	1.44	J	4.59	—	—	—	—	—	—	—	—
ICPP-1795	558–573	Above interbed	5HI05902	10/9/02	—	—	—	—	6.92	1.55	J	4.99	—	—	—	—	—	—	—	—
ICPP-1795	579–594	z-1	5HI04901	10/9/02	1.26	0.47	UJ	1.47	—	—	—	—	4.11	0.62	—	0.73	7,170	261	—	440
ICPP-1795	579–594	Within interbed	5HI06101	10/9/02	0.38	0.05	—	0.15	13.70	1.93	—	6.03	—	—	—	—	—	—	—	—
ICPP-1795	579–594	Within interbed	5HI06102	10/9/02	—	—	—	—	14.10	1.90	—	5.94	—	—	—	—	—	—	—	—
ICPP-1795	608–623	Z-10	5HI05801	10/9/02	0.00	0.28	U	1.07	—	—	—	—	7.41	0.92	—	0.59	6,370	254	—	454
ICPP-1795	608–623	Below interbed	5HI06001	10/9/02	0.43	0.07	—	0.22	17.70	1.70	—	5.15	—	—	—	—	—	—	—	—
ICPP-1795	608–623	Below interbed	5HI06002	10/9/02	—	—	—	—	13.40	1.58	—	4.88	—	—	—	—	—	—	—	—
ICPP-1796	485[a]–487	Z-2	5HI00201	10/7/02	0.00	0.51	U	1.39	—	—	—	—	8.33	1.06	—	0.62	6,380	253	—	450
ICPP-1796	485[a]–487	Z-2	5HI00202	10/7/02	0.57	0.26	UJ	0.68	—	—	—	—	8.86	1.18	—	0.67	5,400	218	—	392
ICPP-1796	490–505	Z-3	5HI00301	10/7/02	0.00	0.41	U	1.20	—	—	—	—	7.94	1.05	—	0.80	6,080	279	—	520
ICPP-1796	490–505	Above Interbed	5HI01101	10/7/02	0.58	0.10	—	0.32	25.50	1.60	—	4.53	—	—	—	—	—	—	—	—
ICPP-1796	490–505	Above Interbed	5HI01102	10/7/02	0.66	0.08	—	0.24	27.00	1.61	—	4.53	—	—	—	—	—	—	—	—
ICPP-1796	604–613	Within interbed	5HI01301	9/27/02	0.56	0.05	—	0.13	25.40	2.01	—	5.92	—	—	—	—	—	—	—	—
ICPP-1796	604–613	Within interbed	5HI01302	9/27/02	—	—	—	—	25.00	2.26	—	6.77	—	—	—	—	—	—	—	—
ICPP-1796	604–613	Z-1	5HI00101	9/27/02	1.05	0.48	UJ	1.45	—	—	—	—	3.74	0.56	—	0.79	5,970	275	—	515
ICPP-1796	632–663	Below interbed	5HI01201	10/3/02	0.04	0.01	UJ	0.06	-2.85	1.82	U	6.24	—	—	—	—	—	—	—	—
ICPP-1796	632–663	Below interbed	5HI01202	10/3/02	—	—	—	—	-4.22	2.20	U	7.56	—	—	—	—	—	—	—	—
ICPP-1796	632–663	Z-10	5HI01001	10/3/02	-0.48	0.37	U	1.23	—	—	—	—	0.20	0.21	U	0.91	1.690	190	—	507
ICPP-1797	472[a]–503	Z-2	5HI01801	11/13/02	1.74	0.62	U	0.80	—	—	—	—	5.35	0.77	—	0.80	7,330	273	—	272
ICPP-1797	472[a]–503	Above Interbed	5HI02701	11/13/02	0.88	0.08	J	0.20	28.70	2.24	—	6.27	—	—	—	—	—	—	—	—
ICPP-1797	472[a]–503	Above Interbed	5HI02702	11/13/02	—	—	—	—	39.40	2.91	—	8.04	—	—	—	—	—	—	—	—
ICPP-1797	506–521	Z-3	5HI01901	11/13/02	0.74	0.25	UJ	0.92	—	—	—	—	4.61	0.56	—	0.43	7,150	270	—	273
ICPP-1797	522–537	Z-4	5HI02001	11/13/02	1.28	0.54	UJ	1.43	—	—	—	—	5.09	0.65	—	0.51	7,000	268	—	274
ICPP-1797	552–567	Z-5	5HI02101	11/13/02	0.08	0.32	U	1.23	—	—	—	—	1.90	0.27	—	0.39	7,840	281	—	271
ICPP-1797	578–593	Z-6	5HI02201	11/14/02	0.28	0.35	U	1.26	—	—	—	—	1.15	0.40	UJ	1.43	8,400	291	—	271
ICPP-1797	589–604	Z-1	5HI01701	11/14/02	0.17	0.38	U	1.34	—	—	—	—	4.48	0.55	—	0.44	6,930	266	—	274
ICPP-1797	589–604	Within interbed	5HI02901	11/14/02	0.73	0.06	J	0.16	30.90	2.76	—	7.91	—	—	—	—	—	—	—	—
ICPP-1797	589–605	Within interbed	5HI02902	11/14/02	—	—	—	—	33.20	2.89	—	8.25	—	—	—	—	—	—	—	—
ICPP-1797	629–648[b]	Below interbed	5HI02801	10/18/02	0.33	0.05	J	0.14	22.80	2.83	—	8.15	—	—	—	—	—	—	—	—

Table 3-7. (continued)

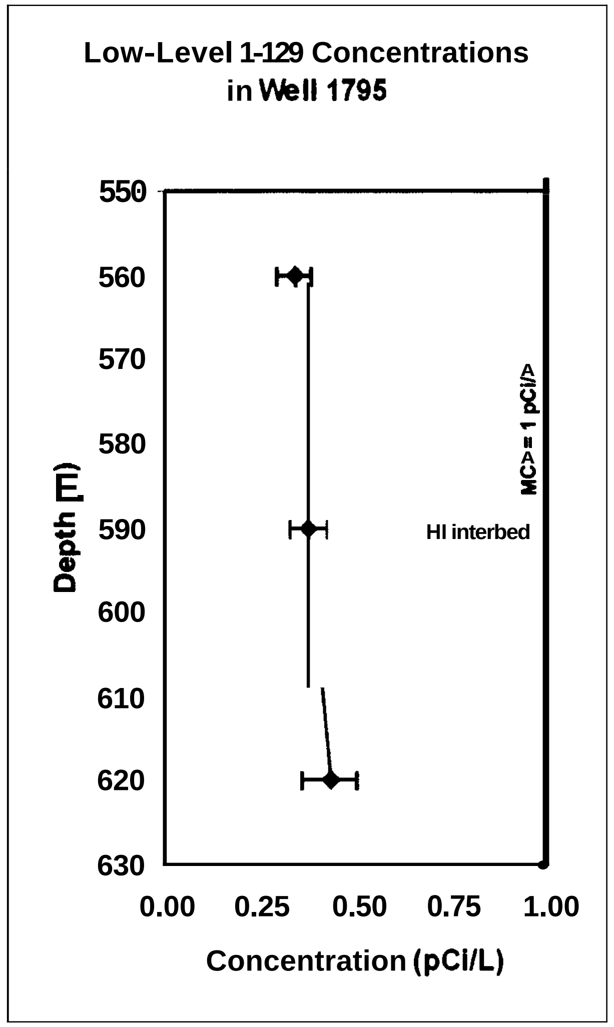
Location	Depth (ft)	Zone	Sample Number	Date Sample Collected	I-129 Result (pCi/L)	I-129 Result Uncertainty (+/- 1 sigma)	I-129 Qualifier Flag	I-129 MDA (pCi/L)	Tc-99 Result (pCi/L)	Tc-99 Result Uncertainty (+/- 1 sigma)	Tc-99 Qualifier Flag	Tc-99 MDA (pCi/L)	Sr-90 Result (pCi/L)	Sr-90 Result Uncertainty (+/- 1 sigma)	Sr-90 Qualifier Flag	Sr-90 MDA (pCi/L)	Tritium Result (pCi/L)	Tritium Result Uncertainty (+/- 1 sigma)	Tritium Qualifier Flag	Tritium MDA (pCi/L)
ICPP-1797	629–648[b]	Below interbed	5HI02802	10/18/02	—	—	—	—	22.10	2.89	—	8.39	—	—	—	—	—	—	—	—
ICPP-1797	629–648[b]	Z-10	5HI02601	10/18/02	0.55	0.38	U	1.49	—	—	—	—	5.46	0.72	—	0.32	4,010	142	—	290
ICPP-1798	480[a]–507	Z-2	5HI03401	11/8/02	0.73	0.36	U	1.38	—	—	—	—	0.31	0.12	UJ	—	8,080	289	—	277
ICPP-1798	511–526	Z-3	5HI03501	11/8/02	0.76	0.38	UJ	1.19	—	—	—	—	0.18	0.10	U	0.39	8,460	292	—	271
ICPP-1798	528–543	Z-4	5HI03601	11/8/02	0.31	0.64	U	0.89	—	—	—	—	-0.07	0.11	U	0.55	7,820	283	—	275
ICPP-1798	552–568	Z-5	5HI03701	11/8/02	0.25	0.30	U	1.19	—	—	—	—	0.08	0.12	U	0.48	7,970	287	—	277
ICPP-1798	552–567	Z-5	5HI03702	11/8/02	0.82	0.32	UJ	1.37	—	—	—	—	-0.01	0.08	U	0.42	8,600	296	—	274
ICPP-1798	552–567	Above Interbed	5HI04301	11/8/02	0.59	0.07	J	0.19	12.50	2.07	—	6.41	—	—	—	—	—	—	—	—
ICPP-1798	552–567	Above Interbed	5HI04301	11/8/02	—	—	—	—	9.82	2.13	—	6.73	—	—	—	—	—	—	—	—
ICPP-1798	573–588	Z-6	5HI03801	11/8/02	0.17	0.64	U	1.16	—	—	—	—	0.12	0.10	U	0.44	8,960	304	—	277
ICPP-1798	604–613	Within interbed	5HI04501	10/28/02	0.03	0.01	UJ	0.05	0.49	2.47	U	8.36	—	—	—	—	—	—	—	—
ICPP-1798	604–613	Within interbed	5HI04502	10/28/02	—	—	—	—	4.12	2.58	U	8.48	—	—	—	—	—	—	—	—
ICPP-1798	604–613	Z-1	5HI03301	10/28/02	0.63	0.39	U	1.42	—	—	—	—	0.62	0.24	UJ	0.73	5,590	159	—	284
ICPP-1798	699–724[b]	Below interbed	5HI04401	11/5/02	0.00	0.02	U	0.07	9.38	2.69	—	8.53	—	—	—	—	—	—	—	—
ICPP-1798	699–724[b]	Below interbed	5HI04402	11/5/02	—	—	—	—	9.72	2.79	—	8.84	—	—	—	—	—	—	—	—
ICPP-1798	699–724[b]	Z-10	5HI04201	11/5/02	0.03	0.37	U	1.25	—	—	—	—	1.45	0.24	J	0.42	2.620	122	—	283

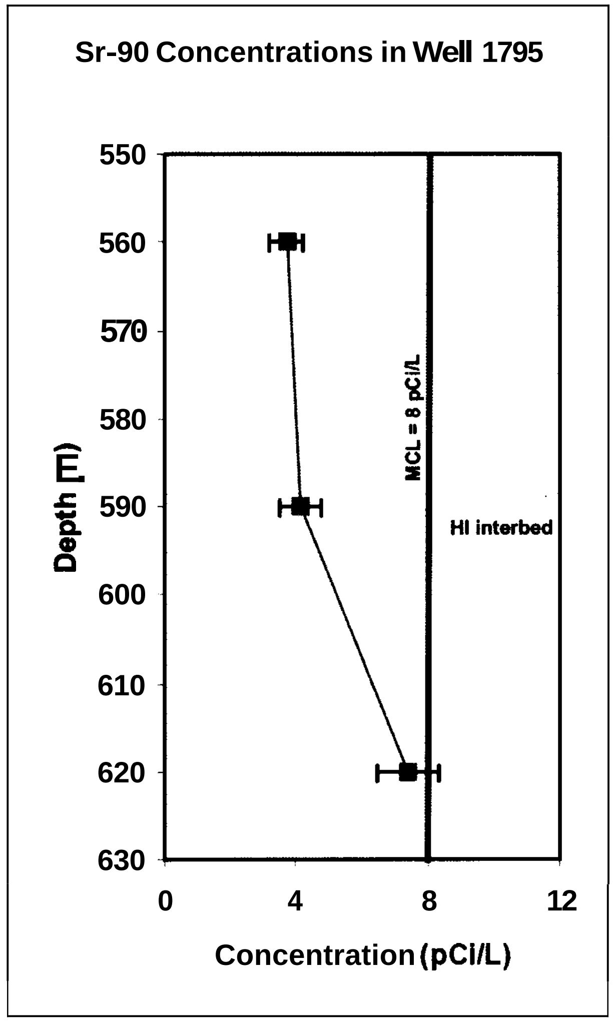
a. No upper packer. Sample zone is from the water table to the lower packer.

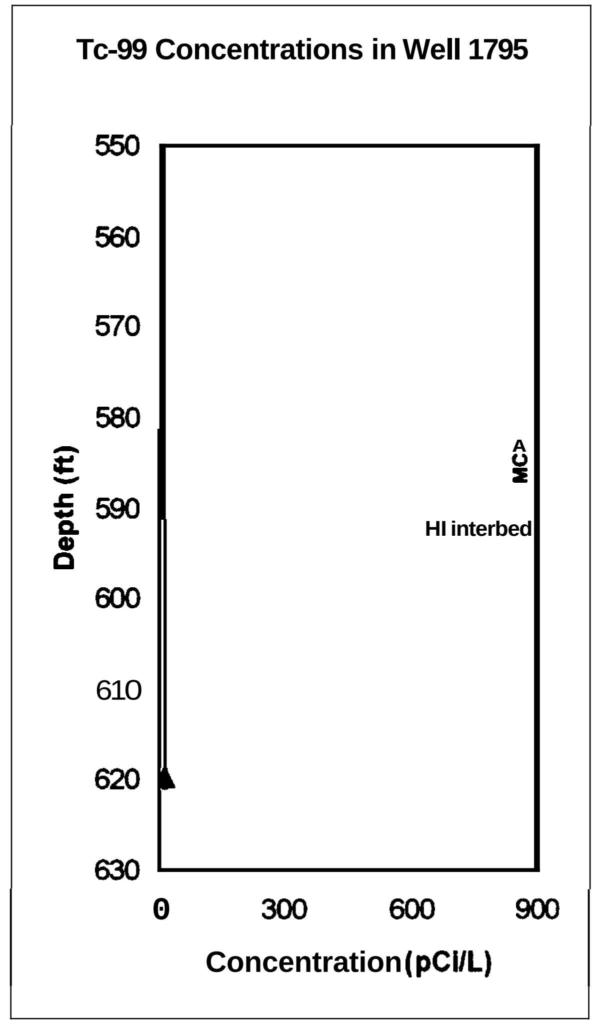
b. No lower packer. Sample zone is from the upper packer to the bottom of borehole.

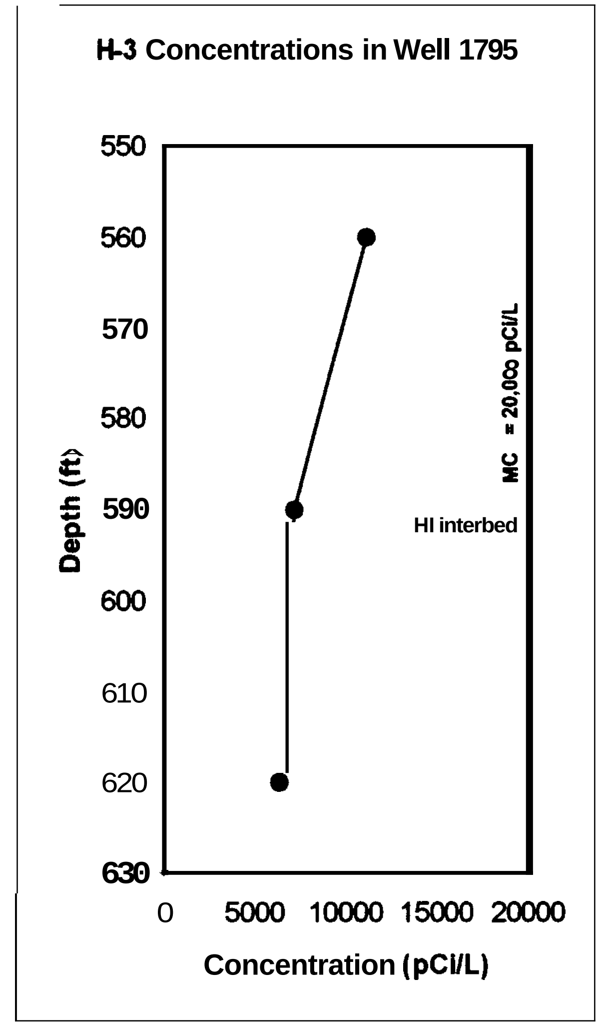
ICPP = Idaho Chemical Processing Plant

MDA = minimum detectable activity









LL I-129 Concentrations in Well 1795

Depth (ft)	Result (pCi/L)	Flag
560	0.34+/-0.04	
590	0.38+/-0.05	
620	0.43+/-0.07	

Sr-90 Concentrations in Well 1795

Depth (ft)	Result (pCi/L)	Flag
560	3.72+/-0.50	
590	4.11+/-0.62	
620	7.41+/-0.92	

Tc-99 Concentrations in Well 1795

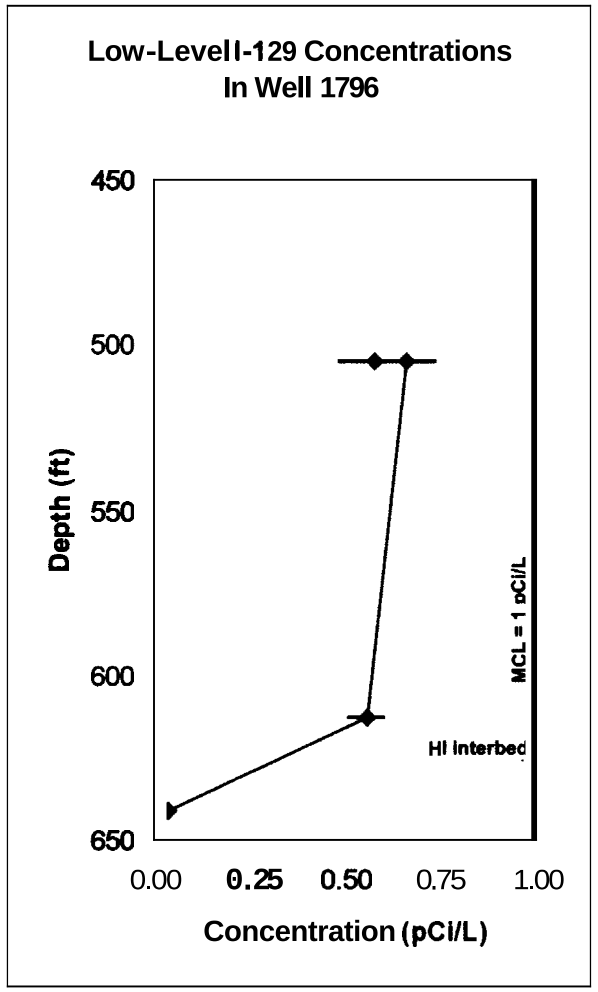
Depth (ft)	Result (pCi/L)	Flag
560	6.95+/-1.44	J
560	6.92+/-1.55	J
590	13.7+/-1.93	
590	14.1+/-1.9	
620	17.7+/-1.7	
620	13.4+/-1.58	

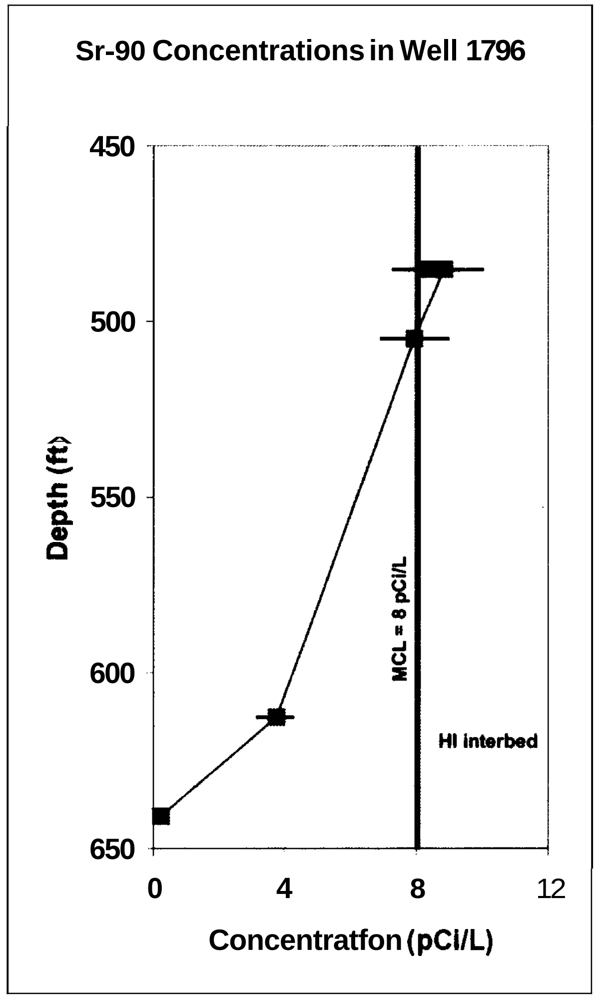
H-3 Concentrations in Well 1795

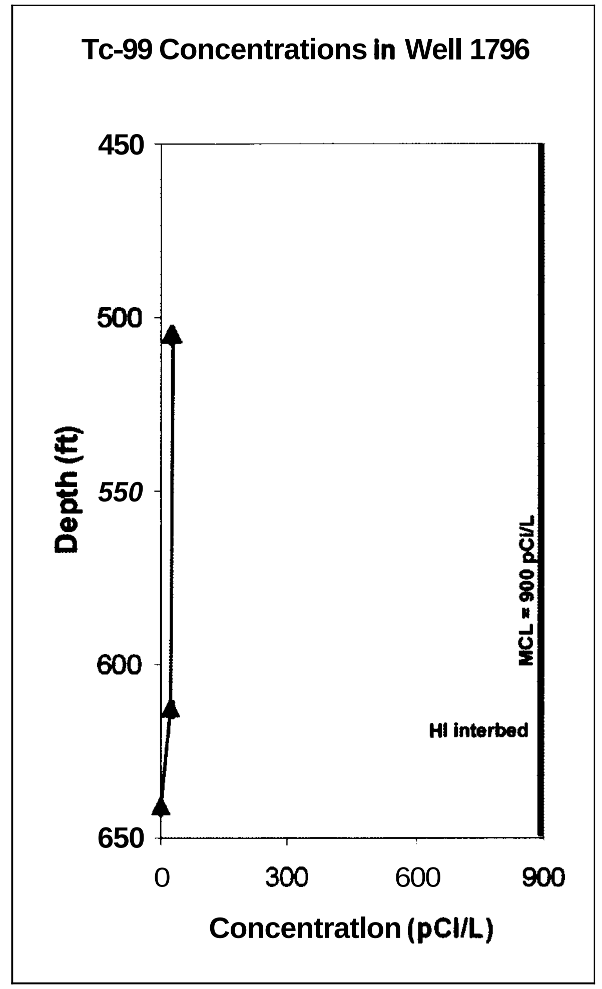
Depth (ft)	Result (pCi/L)	Flag
560	11100+/-317	
590	7170+/-261	
620	6370+/-254	

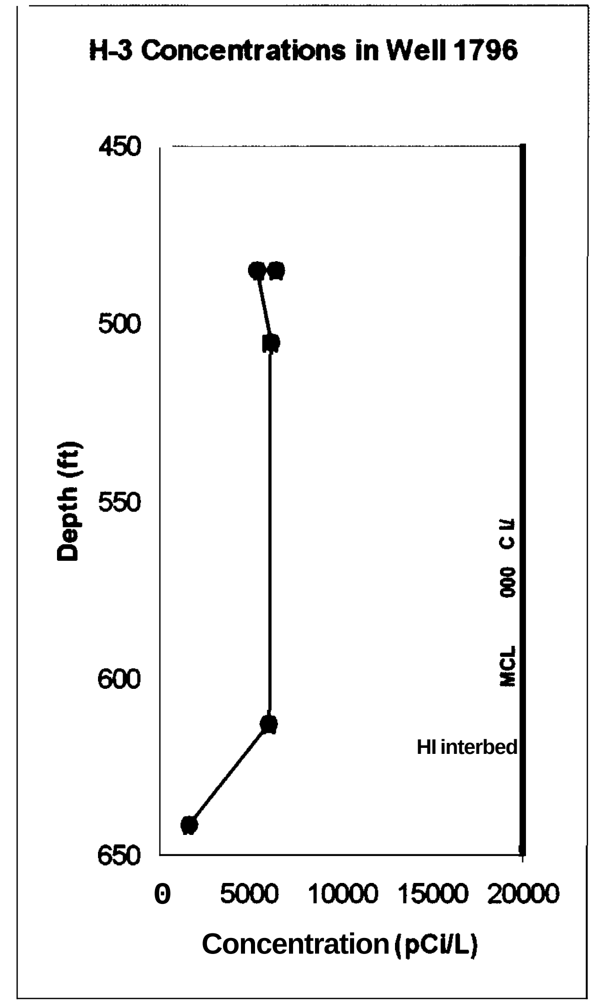
*Error bars represent +/- 1 standard deviation.

Figure 3-5. Contaminant profile charts for boring ICPP-1795.









LL I-129 Concentrations in Well 1796		
Depth (ft)	Result (pCi/L)	Flag
505	0.58+/-0.10	
505	0.66+/-0.08	
613	0.56+/-0.05	
641	0.04+/-0.01	UJ

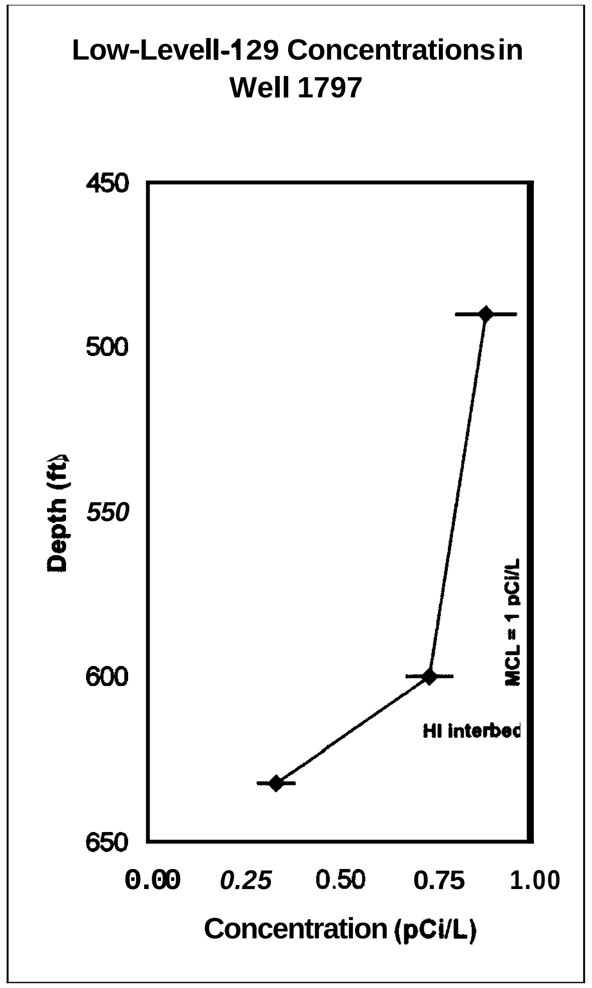
Sr-90 Concentrations in Well 1796		
Depth (ft)	Result (pCi/L)	Flag
485	8.33+/-1.06	
485	8.86+/-1.18	
505	7.94+/-1.05	
613	3.74+/-0.56	
641	0.20+/-0.21	U

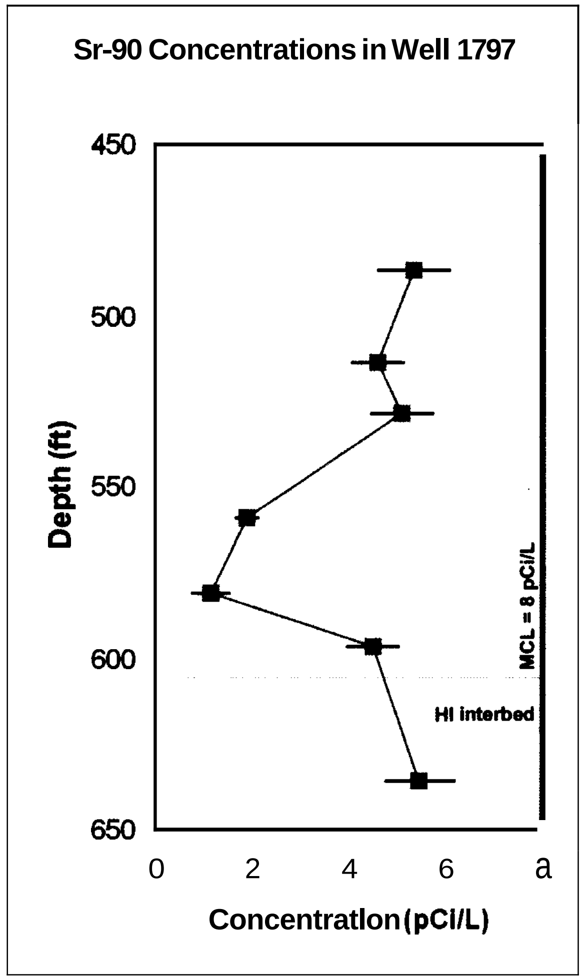
Tc-99 Concentrations in Well 1796		
Depth (ft)	Result (pCi/L)	Flag
505	25.5+/-1.6	
505	27.0+/-1.6	
613	25.4+/-2.0	
613	25.0+/-2.3	
641	(-2.85+/-1.8)	U
641	(-4.22+/-2.2)	U

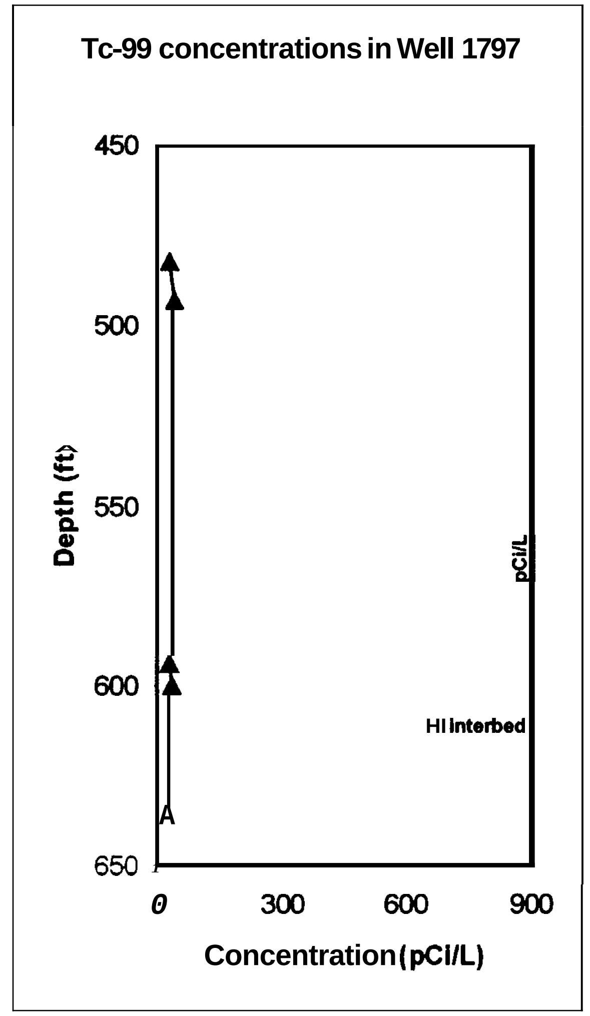
H-3 Concentrations in Well 1796		
Depth (ft)	Result (pCi/L)	Flag
485	6380+/-253	
485	5400+/-218	
505	6080+/-279	
613	5970+/-275	
641	1690+/-190	

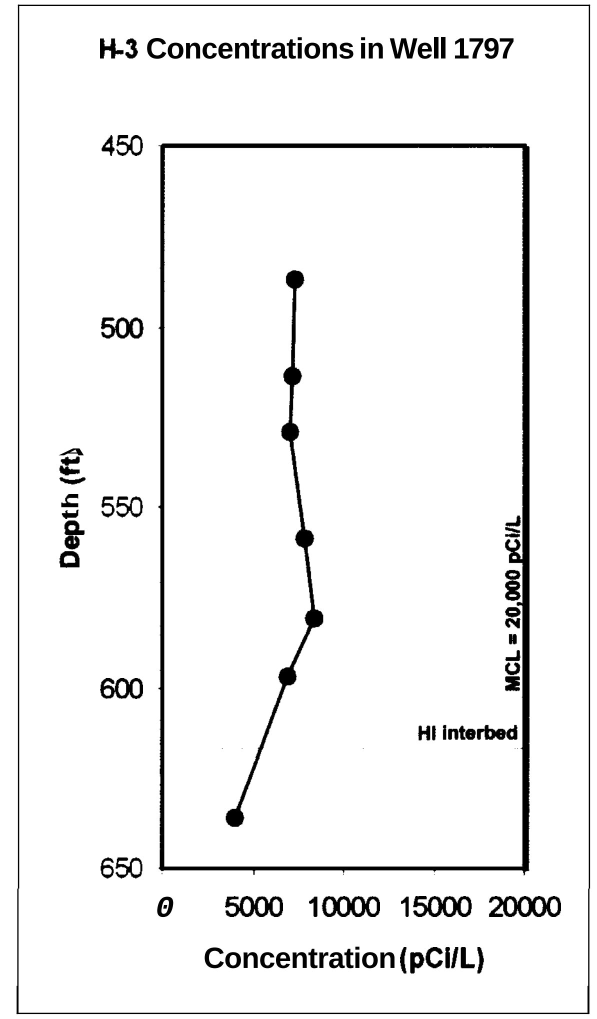
*Error bars represent +/- 1standard deviation.
'Results in parenthesesare representedon the graph as havinga value of zero.

Figure 3-6. Contaminantprofile charts for boring ICPP-1796.









LL I-129 Concentrations in Well 1797

Depth (ft)	Result (pCi/L)	Flag
472-503	0.88+/-0.08	J
589-605	0.73+/-0.06	J
632	0.33+/-0.05	J

Sr-90 Concentrations in Well 1797

Depth (ft)	Result (pCi/L)	Flag
472-503	5.35+/-0.77	
506-521	4.61+/-0.56	
522-537	5.09+/-0.65	
551-567	1.go+/-0.27	
578-593	1.15+/-0.40	UJ
589-605	4.48+/-0.55	
636	5.46+/-0.72	

Tc-99 concentrations in Well 1797

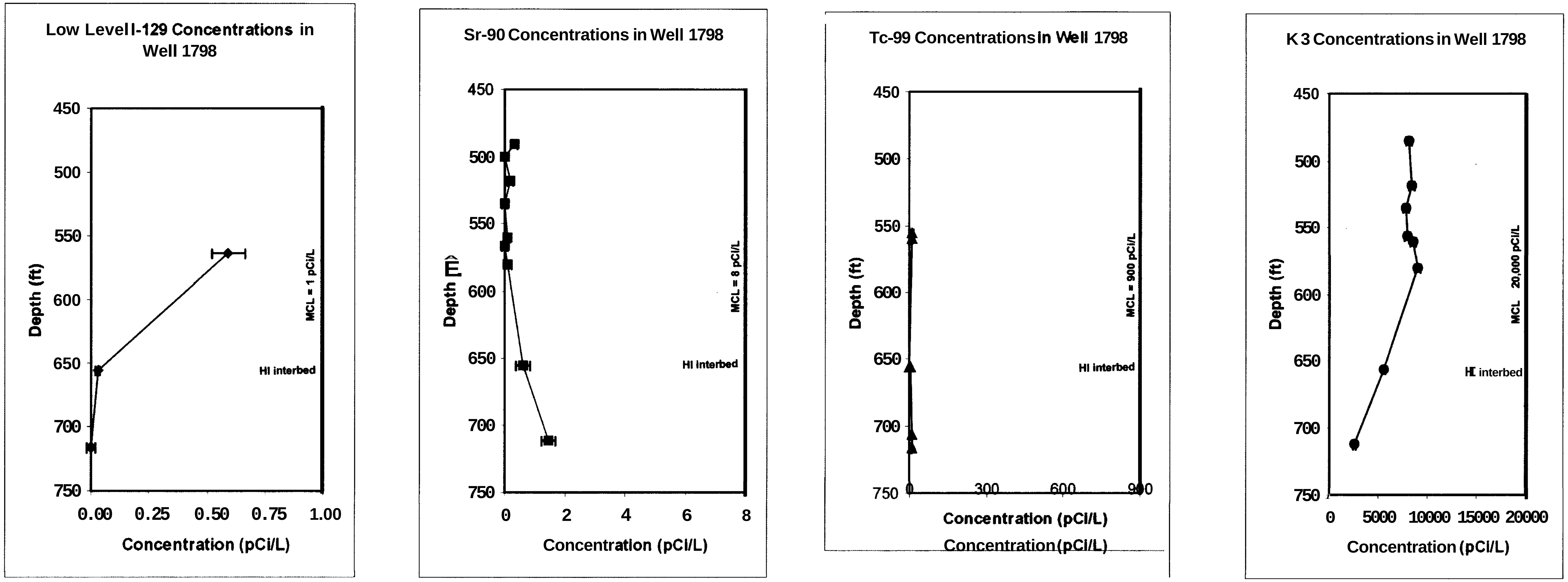
Depth (ft)	Result (pCi/L)	Flag
472-503	28.7+/-2.24	
472-503	39.4+/-2.91	
589-605	30.9+/-2.76	
589-605	33.2+/-2.89	
636	22.8+/-2.83	
636	22.1+/-2.89	

H-3 Concentrations in Well 1797

Depth (ft)	Result (pCi/L)	Flag
472-503	7330+/-273	
506-521	7150+/-270	
522-537	7000+/-268	
551-567	7840+/-281	
578-593	8400+/-291	
589-605	6930+/-266	
636	4010+/-142	

*Error bars represent +/- 1standard deviation.

Figure 3-7. Contaminant profile charts for boring ICPP-1797



LL I-129 Concentrations in Well 1798		
Depth (ft)	Result (pCi/L)	Flag
552-567	0.59+/-0.07	J
656	0.03+/-0.01	UJ
699-724	(-0.003+/-0.02)	U

Sr-90 Concentrations in Well 1798		
Depth (ft)	Result (pCi/L)	Flag
480-507	0.31+/-0.12	UJ
480-507	0.00+/-.11	U
511-525	0.18+/-0.10	U
528-542	(-0.067+/-0.11)	U
552-567	0.08+/-0.12	U
552-567	(-0.01+/-0.08)	U
573-588	0.12+/-0.10	U
656	0.62+/-0.24	UJ
699-724	1.45+/-0.24	J

Tc-99 Concentrations in Well 1798		
Depth (ft)	Result (pCi/L)	Flag
552-567	12.5+/-2.1	
552-567	9.82+/-2.13	
656	0.49+/-2.47	U
656	4.12+/-2.58	U
699-724	9.38+/-2.69	
699-724	9.72+/-2.79	

H-3 Concentrations in Well 1798		
Depth (ft)	Result (pCi/L)	Flag
480-507	8080+/-289	
511-525	8460+/-292	
528-542	7820+/-283	
552-567	7970+/-287	
552-567	8600+/-296	
573-588	8960+/-304	
656	5590+/-159	
699-724	2620+/-122	

*Error bars represent +/- 1standard deviation.
*Results in parentheses are represented on the graph as having a value of zero.

Figure 3-8. Contaminant profile charts for boring ICPP-1798.

3.2.6.7 Iodine-729. In general, two groundwater samples were collected at each depth for 1-129 analysis. One sample was analyzed for 1-129 using a method that has an MDA (detection limit) of approximately 1 pCi/L (high-level 1-129). The high-level 1-129 analyses were performed in case higher 1-129 activities (>10 pCi/L) were encountered in groundwater from the HI interbed, as had been predicted by the computer model. Another sample was analyzed using a low-level 1-129 analytical method with an MDA of approximately 0.1 pCi/L. The low-level 1-129 proved the most useful. All 1-129 activities in groundwater were below the 1-pCi/L MCL and the highest reported 1-129 activity was 0.88 ±0.08 pCi/L (472-503-ft depth in ICPP-1797). Note that all of the high-level sample results were assigned U or UJ flags, indicating that 1-129 was not present above the MDA of approximately 1.0 pCi/L.

3.2.6.2 Strontium-90. The Sr-90 activities were below the 8-pCi/L MCL in all samples except for two samples taken from ICPP-1796 at 485 ft below ground surface (above the HI interbed). The Sr-90 activities in groundwater at this depth were 8.33 ±1.06 pCi/L and 8.86 ±1.18 pCi/L, which are slightly over the 8-pCi/L MCL. With respect to Boreholes ICPP-1795 and ICPP-1798, the highest Sr-90 activities were observed below the HI interbed.

3.2.6.3 Tritium. Tritium activities in groundwater were below the MCL (20,000 pCi/L) at every depth and sample location. The highest tritium activity observed was 11,100±3 17 pCi/L at *560* ft below ground surface (above the HI interbed) in Borehole ICPP-1795.

3.2.6.4 Tc-99 Duplicate Sample Results. Groundwater samples were collected for Tc-99 analysis above, within, and below the HI interbed. All Tc-99 activities were below the 900-pCi/L MCL, with the highest activity reported as 39.4 ±2.91 pCi/L in ICPP-1797 (472–503 ft below ground surface).

As described in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a), the Tc-99 results were used to determine the need to perform more costly duplicate 1-129 analyses. **A** single Tc-99 sample was collected when sampling began at a specific depth and another duplicate sample was collected at the end of the sampling period at that depth. ***An*** additional low-level 1-129 sample also was collected and archived from the sample depth interval. Then, the sample results from the two Tc-99 samples were statistically compared to determine the variability associated with the sample collection process. This was done by computing the mean difference of the duplicate results by the following procedure shown in Equation (1) below, as specified in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a):

$$MD = \frac{|S - D|}{\sqrt{\left(\sigma_s^2 + \sigma_D^2\right)}} \tag{1}$$

where

MD	=	the mean difference (MD) of the duplicate results
S	–	the original sample result (as pCi/g or pCi/L)
D	–	the duplicate sample result (as pCi/g or pCi/L)
σ_s	–	the associated total propagated 1 o uncertainty of the original result (as standard deviation)
σ_D	_	the associated total propagated 1σ uncertainty of the duplicate result (as a standard deviation).

An MD value of approximately 3 indicates that the results agree (overlap) at the 30 confidence interval. An MD value of 1 indicates that the results agree at the 1σ confidence interval. If the MD >3, the relative percent difference (RPD) would be calculated, and if the result was less than 20%, then the samples were considered to be in agreement.

For each pair of duplicates, the duplicate results agreed with one another at the 30 confidence interval, indicating that all results were representative and replicable. Because the duplicate Tc-99 results were statistically identical, duplicate I-129 laboratory analyses were not performed, as specified in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a). Table 3-8 summarizes the results of these calculations.

Table 3-8. The Tc-99 duplicate sample results.

Well	Depth (ft)	Tc-99 Result 1 (pCi/L)	Sample Error (pCi/L)	Tc-99 Result 2 (pCi/L)	Sample Error (pCi/L)	Mean Difference”	Relative Percent Difference[b]
1795	560	6.95	1.44	6.92	1.55	0.01	0.43
1795	590	14.1	1.9	13.7	1.93	0.15	2.88
1795	620	17.7	1.7	13.4	1.58	1.85	27.65
1796	505	27	1.61	25.5	1.6	0.66	5.71
1796	613	25.4	2.01	25	2.26	0.13	1.59
1796	641	-2.85 U	1.82	-4.22 U	2.20	NA	NA
1797	472–503	28.7	2.24	39.4	2.91	2.91	31.42
1797	589–605	30.9	2.76	33.2	2.89	0.58	7.18
1797	636	22.8	2.83	22.1	2.89	0.17	3.12
1798	552–567	12.5	2.07	9.82	2.13	0.90	24.01
1798	656	0.49 U	2.47	4.12 U	2.58	NA	NA
1798	699–724	9.38	2.69	9.72	2.79	0.09	3.56

a. If MD <3, results for duplicates are considered statistically identical.

b. If MD >3 and RPD <20, results for duplicates are considered statistically identical.

MD = mean difference
NA = not applicable
RPD = relative percent difference
U = undetected (data qualifier flag)